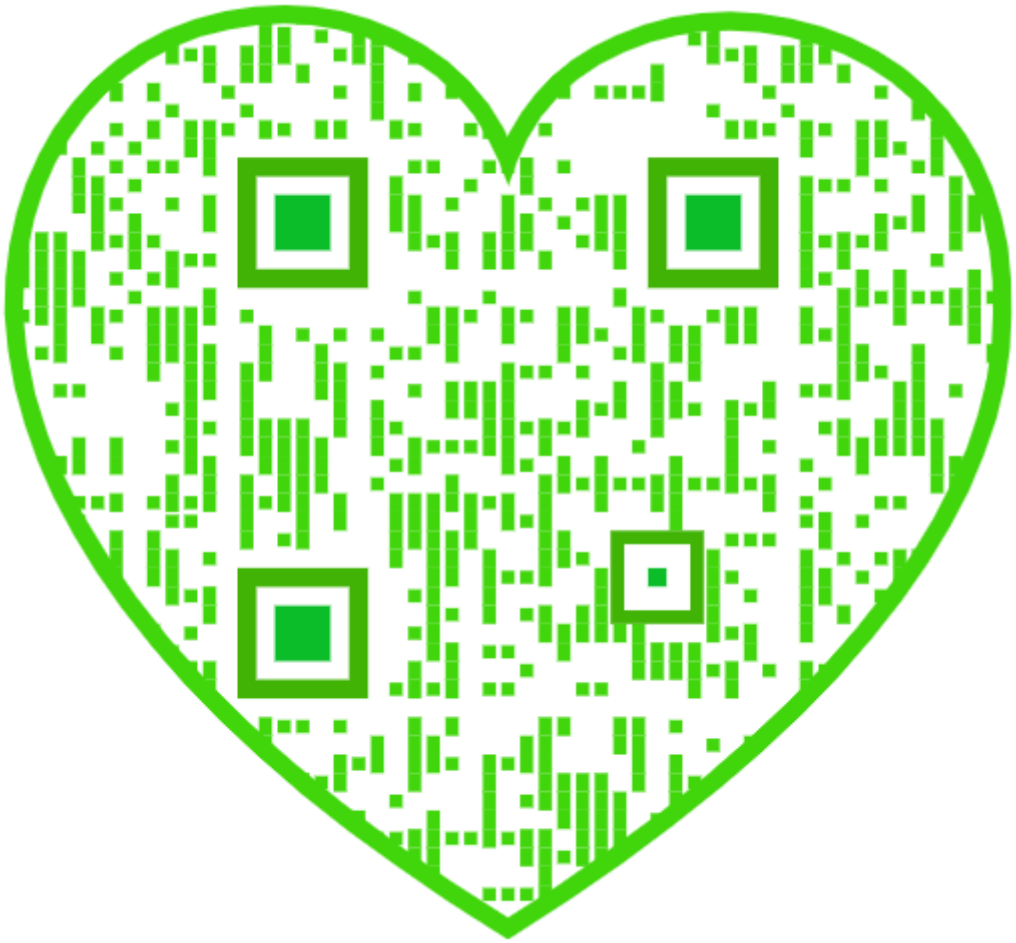
CULTIVATION AND PREPARATION OF COFFEE

GOMEZ



John A. Foster
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CULTIVATION

AND

PREPARATION OF COFFEE

BY

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Agricultural Engineer

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PREFACE.

PUBLIC attention is now being called to this important branch of our agriculture and a great anxiety is shown for information as to the scientific and practical rules for the cultivation of coffee, which have been acquired by observant and practical men throughout the country. In order to satisfy this desire, all parties and all publications in the Republic lend their valuable co-operation, and all unite in endeavoring to resolve the important problem of the extension of cultivation in this and other important fruits of the tropics. The general belief is that the present financial conditions ought to serve as a lesson, and that they ought to encourage us in our struggle to bring Mexico to the front as an agricultural country.

Mexico in fact, contains every class of climate, from the coldest to the hottest, and it can also count on a great variety of soils which only require the help of work and capital to produce valuable fruits; but what is required to bring forth such wealth? The answer is, that we only require to give a good direction to the

natural forces, and to adapt our artificial forces in such a manner as to obtain the best results.

Mr. G. Gomez, author of this valuable book, has contributed largely to the solving of this difficult problem with a study of one of our most promising branches of industry. In the pamphlet that he publishes he gives a summary of the rules that have to be observed, not only with respect to the cultivation of the plant, but also with respect to the treatment of the product, as far as has been written in our own country or abroad, and he has shown good judgment in eliminating that which was not adapted to the conditions of the country, or which was in contradiction to scientific discovery.

The plan adopted by Mr. Gomez, is that of explaining all the different operations which have to be carried out respecting the coffee tree or its product; that is to say, he carries his study from the seed-bed up to the delivery of the coffee in the market. In order to facilitate the understanding of some of the operations, he has drawn the figures which accompany his monograph, and these illustrations will be a valuable help to the student of the subject.

Amongst the different points touched in the pamphlet, the question of pruning is the one that merits special attention. The author very clearly explains the different ways of carrying out this operation, and the style adapted to the special conditions of the plantation, so as to produce the best fruit that the circumstances will allow. He also gives full explanations as to the flowering of the tree, which in many places, gives the impression that it flowers several times in the year.

The coffee tree commences to bear fruit at about the age of three years, and if it could be possible by any means, based on the principles of our arboriculture, to accelerate the production, or rather shorten the time to the first bearing, a great stride will have been taken in agricultural progress. How can this result be obtained? Perhaps, by the application of some of the different methods for propagating the plant, such as grafting, for instance. If our intelligent and studious friend, Mr. Gomez, should find an opportunity in the course of his study of making any experiments of this class, we desire him the most complete success in such experiments.

Although to a certain extent in a superficial manner, the pamphlet treats of the machinery employed in the preparation of the coffee and shows the models that are principally employed.

The pamphlet by Mr. Gomez is presented with the utmost modesty, as he has no pretentions to pronouncing the last word on the subject of such an interesting cultivation; but we consider it very useful to those who enter into that business and full of valuable information for beginners.

We, therefore, beg the sympathies of the reader for this pamphlet, as it supplies a real necessity and gives information which has long been required in this country, and is written with the hope of affording service to his countrymen.

Mexico, January 1894.

ANDRÉS BASURTO LARRAINZAR.
Chief Clerk. Second Section.
Dept. of Fomento.

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HISTORY.

Several authors believe that the original home of coffee is found in Upper Ethiopia, from which country it was carried to Arabia Felix. The Abbe Raynal in his "Philosophical and Political History of the Commerce and European Establishments in India" asserts that this tree has been known from time immemorial in that country, where it is still successfully cultivated.

Coffee was not known by the nations of antiquity. Neither the Greeks or the Romans understood its use, although some authors argue that this beverage was known in the most remote times and that Pietro della Valle has affirmed that it was the *Nepentes* which Melena received from an Egyptian lady, and the same which Homer praised as adapted to calm the most violently excited spirit, under affliction or misfortune. Paschius, in this treaty *De Novis Invertis*, which was published in Leipsic in 1700, asserts that coffee was mentioned amongst the presents which Abigail made to David in order to obtain his favor.

The cradle of the coffee cultivation is generally believed to have been in Upper Ethiopia, where the berry has been used from time immemorial. The Persians were the second nation that made use of coffee, and the Arabs finally introduced it

into Europe. Many fables have been told with respect to the discovery of coffee, amongst others, there is one of a poor Dervish who lived in a Valley of Arabia and whose only possessions consisted of a small hut and a few goats. One day when the latter returned from the fields, he noted with surprise the agitation which the animals displayed when they were in the fold; on the next day he followed them and observed that they chewed the leaves and fruit of a shrub which he had not previously observed.

He experimented with the fruit in his own person and found that it created an extraordinary animation, accompanied with such a degree of loquacity that his neighbors thought him an extraordinary and inspired man. He reported his discovery to the other Dervishes, who also began to use the fruit of that tree and to propagate its use. It is very probable that this fable, which was adopted by Dufour on the faith of Fuasto Naironi, Maronite Professor of Oriental languages in Rome, who published in that City one of the first treatises on the subject, was invented by the Arabs in order to create a belief that coffee was indigenous to their country.

The Persians relate that when Mahommed was sick, the Archangel Gabriel invented this beverage in order to restore his health.

Another story is, that the superior of an Arab convent, having heard of the effects that the coffee had produced on the goats of the Dervish, and observing that his monks allowed themselves to fall asleep during their nightly religious exercises instead of giving the proper attention and due respect, obliged them to drink an infusion of this berry which produced the best results. The use of it was thus established, and was shortly extended over the whole of Arabia, where it acquired a great reputation and great demand in the markets.

Some authors mention a Mollah called Chadely, who finding himself unable to attend to his nightly orations on account of sleepiness, made a trial of this beverage, whose good effects he

shortly proved, and which he confided to the other Dervishes who afterwards made it public.

Let this be how it may, it is very certain that about the middle of the ninth century of the Hegira (XV of the Christian Era), the Arabs began to cultivate coffee.

Gemaleddin Abou Abdallah, Mohammed Ben Said (surnamed Dhabbani because he was a native of Dhabban, a small village of Yemen), was a Mufti of Aden, a famous town and port of Arabia, and situated on the eastern side of the mouth of the Red Sea. He had occasion to go to Persia on business, and remained there sometime, observing that the inhabitants made use of coffee and greatly praised the properties of this beverage. On returning to Aden he fell sick and remembering what he had been told with respect to coffee, he drank a cup of the infusion and got well. He observed that it had the property of producing wakefulness and alleviating torpidity, as well as of imparting lightness and agility to the body. He therefore introduced the custom of drinking this beverage in Aden. Following his example, all the inhabitants of the city, even to the lower classes, adopted the custom of drinking coffee, some with the object of following their studies and others to follow their mechanical pursuits. From that time, the use of coffee became every day more common. The Fakirs drank coffee in the mosques, whilst they were singing the praises of the Lord. The liquor was kept in a great vase of red earthenware from which the superior drew it out with a ladle and distributed to each one of the fakirs as they sang their daily prayers; all the servants of the temple also drank the beverage.

Gemaleddin died in 875 (1459 of the Christian Era).

The use of coffee was never interrupted in Aden, and it is said the Arabs never drink this delicious liquor without expressing a hope that Gemaleddin is in heaven as a recompense for his great gift to humanity. Towards the end of the 11th century of the Mohammedan Era, the use of coffee gradually extended from Aden to the cities of Mecca and Medina, from

whence it spread over the whole of Arabia, so that within a short time, both in that country, as well as in Persia, public places were set up to which men could come to drink coffee and amuse themselves. In these establishments chess was played, a game in which the Arabs excell, even above the people of other nations; poets came there to recite their verses and everybody drank coffee. Although the government at that time was very despotic, it tolerated these establishments.

From Arabia the use of coffee passed over to Egypt, reaching the city of Cairo at the beginning of the 10th Century of the Hegira, or 16th. of the Christian Era. From Egypt, it afterwards passed over to Syria, where it was principally adopted in the cities of Damascus and Aleppo, where it was established with very little difficulty, and from which it spread to the other cities of that great province.

The prosperity of coffee dates from this period. Every one wanted to use it, appreciating the agreeable qualities and healthy virtues of this beverage, which is so well adapted to the use of those nations who are enervated by the hot climate and the abuse of pleasure.

The first misfortune that befell coffee, took place in Mecca, in the year 917 of the Hegira (1511 of the Christian Era). Two doctors who were brothers and natives of Persia, managed to persuade the Emir Khair–Beg–Mimar that coffee was an intoxicating beverage, which gave rise to diversions prohibited by the law of Mohammed.

Khair–Beg called a meeting of learned men and doctors to deliberate on the subject. The former declared that public cafés were contrary to the Mohammedan religion, and the latter, that the liquor which was there served was prejudicial to health. Several individuals asserted that they had suffered from the use of coffee, and one of those who were present, even asserted that it was as intoxicating as wine. This declaration greatly amused the meeting. A general cry was raised that that man had drunk wine, and he found himself obliged to confess his

sin, receiving eighty strokes of a stick in payment for his folly.

Khair–Beg then solicited a rescript from the Sultan prohibiting the sale of coffee in Mecca, and gave a provisional order prohibiting its sale in public establishments.

But in spite of this order, coffee drinking was continued in private houses, although with secrecy, because Khair–Beg having heard of a person in the city who had been guilty of drinking coffee and thereby violating the decree, he had that person punished with the greatest rigor and carried around the public streets and squares mounted on a donkey. Shortly after this, a rescript was received from the Sultan which disgusted the adversaries of coffee, as it declared that the learned men and physicians of Cairo, who ought to be better instructed than those of Mecca, had recognized the innocuous qualities of the beverage, and that the Emir was therefore ordered to retire his prohibition.

Everyone therefore returned to the public use of coffee, knowing that it was already the fashion in Cairo where the Sultan resided.

In the year 932, the Scheik Sidi–Mohammed–Ben Arrak having heard that criminal actions were done in those places where coffee was drunk, gave orders to the governors to suppress the houses where the beverage was sold, without at the same time, prohibiting its use in the interior of private dwellings.

After his death, the public houses were again opened.

In the year 941 of the Hegira (1534 of the Christian Era), a fanatic preached a violent discourse in the Mosque, and the people excited by his words, broke into the coffee houses, destroyed the furniture and ornaments they found, as well as the vessels employed in the distribution of the liquor, wounded the drinkers and beat the servants.

The city was divided into two parties. The advocates of coffee asserted that it was a pure and healthy beverage which excited merriment and facilitated the singing of God's praises, as well as other devotional exercises.

Those who took the contrary view, considered it a forbidden beverage, and abused all those who used it with the most unmeasured insult. The adversaries of coffee went so far as to say that it was a kind of wine and ought to be included in the same religious prohibition; and they even went so far as to assert that on the day of resurrection, the coffee drinkers would appear with faces blacker than the bottoms of the vessels in which that beverage was prepared.

It became necessary to have recourse to a consultation of jurists. A meeting was called of all the learned men by the Scheik, and they declared that the question had long before been decided in favor of coffee. The Scheik being convinced by the opinions of the most distinguished men, coffee was prepared in his own house and served to all the persons in the assembly, from which date the beverage became more popular than ever. From that date, all attempts to prohibit the use of coffee in Mecca were entirely fruitless. It was also prohibited in Cairo, but with the same result.

In the year 962 of the Hegira (1554 of the Christian Era) and during the reign of Soliman II, surnamed the Great, coffee was introduced in Greece and in Constantinople. A Damascene called Schems, and a resident of Aleppo, called Heken, arrived in Constantinople, where each of them opened a café fitted with sofas for the reception of customers. These establishments were mostly frequented by the learned men, judges, professors and dervishes. Later on, these coffee houses acquired such fame, that people of the highest class, the pashas, the great lords and high dignitaries honored them with their presence. They thus came to be called, the schools of learning.

The Turks adopted the use of this beverage with enthusiasm, and the capital city was very shortly full of Kawha-Kanes, where coffee was distributed; idle persons met there, and public dancers and courtesans came to amuse the customers with their lascivious songs and dances. But a furious storm of persecution soon set in: the priests alleging that their temples

were abandoned for the coffee houses, and a great scandal was created in Constantinople. It was said that the toasted coffee was charcoal and that everything related to that combustible was prohibited by Mohammed. The Mufti sustained the priests, prohibiting the use of this beverage in the capital and ordering the closure of all the coffee houses in the City.

In the establishments where the beverage was sold, games of chess had been introduced, as well as conversation on literary, scientific and art subjects, which very shortly extended to religion and politics.

During the reign of Amurat III, the Mufti got annoyed and suppressed the coffee–houses on account of the newsmongers who met there, but as this prohibition did not extend to the beverage itself, it use was tolerated in private houses. The Turks soon found means to evade the decrees of the Mufti and coffee–houses became more numerous than ever.

Ricault in his History of the Otoman Empire, tells us that during the war with Candia and during the minority of Mohammed IV, the Grand Vizier Kuprugli, closed the coffee–houses on political pretexts. This extreme measure only increased the enthusiasm of the Turks for the beverage and contributed to diminish the government revenues, until it found itself obliged to retire the prohibition, since which time, coffee has come into such common use throughout, Turkey, Egypt and all Musselman countries, that it has taken the place of wine. In the Orient, the husband is in duty bound to provide coffee for his wife, or otherwise, lay himself open to suit for divorce.

In the year 1652, a merchant called Edward in returning from the Levant, brought to England a Greek called Pasqua Rosse who knew how to prepare coffee, and in this manner introduced the beverage into London, where it was favorably received by the English.

Pasqua Rosse having left his master, he established a coffee–house in St. Michael's Alley, Cornhill, which he announced as follows: "The virtues of coffee publicly made and sold by Pas-
" qua Rosse.

"The grain or fruit which is called coffee, is produced by a "shrub which only grows in the deserts of Arabia. Boiled with "pure water after drying and reducing to powder, it constitutes "a simple and innocent beverage adapted to drinking an hour "after dinner.

"It ought to be taken as hot as possible, without producing "excoriation in the mouth.

"The quality of this beverage is cold and dry. Introduced into "the stomach, it preserves the internal heat, assists the diges- "tion, and is therefore good to drink after dinner. It animates 'the spirit and strengthens the heart; it cures headache, and is, "excellent to prevent and cure gout and dropsy. This beverage "is known as the best for old people and children; it is the best "cure for the spleen, hypochondria and love..... In Turkey, "where this beverage is generally used, it has been observed "that people who drink it, never suffer from stone in the blad- "der, gout or dropsy; besides which, it renders the skin clear, "smooth and white.....

"Made and sold in St. Michael's Alley, Cornhill, by Pasqua "Rosse and under his sole direction."

During the reign of Charles II, the consumption of coffee was subject to the same persecutions and the same difficulties that had been found in Turkey.

In 1675, orders were given to close the coffee–rooms, which numbered more than three thousand, on the pretext that they were hot–beds of disorder and sedition. This measure was probably the origin of the abandonment of the use of coffee throughout England, until these later times, when it has been revived and greatly polularized.

But as the favorite beverage of the English is tea, the consumption of coffee is by no means as large as it might be, considering its population; whilst on the other hand, they do not know how to prepare it. In fact, the coffee that is served in public establishments, steamers, etc., is simply detestable.

It was only ten years after the English had adopted the use

of coffee, that it commenced to be consumed in France, where it has since become extremely popular.

Nevertheless, Rauwolf had mentioned the coffee-tree as far back as 1683. Prospero Alpino, a famous physician and botanist of Padua, in 1591 published a work in Venice in which he decribed a tree he had seen in Egypt, and to which he gave the name of *Bon*, *Ban* or *Boun*.

Another edition of this work was published in Paris in the year 1640, with observations and annotations by Veslingius, another celebrated Italian physician. Bacon Verulam, in his work, Sylva Sylvarum published in 1624, spoke of coffee as a beverage commonly used in the East, and Meismar published a treatise in 1621 with respect to this precious berry.

In Italy, the use of coffee dates from the year 1645, and it is said that an Italian called Pietro della Valle brought coffee to Marseilles in 1644, thus proving the error of those who assert that Thevenot was the first to introduce coffee in France, when he did not return from his first voyage until 1657. Shortly after the introduction of coffee into Marseilles by Della Valle, another traveller not only imported coffee, but also the furniture and muslin napkins embroidered in gold, silver and silk, which are employed in serving it by the Turks. But the coffee of that period was only an object of mere curiosity.

But in 1660, several merchants of Marseilles who had lived a long time in the Levant, and who had there acquired the custom of drinking it, had several bales of the berry brought from Egypt.

From Marseilles the use of coffee extended to Lyons, to Provence, and to the neighboring provinces. The first shop opened for the sale of coffee in France was established in Marseilles during the year 1671.

The use of coffee had now become general in Marseilles, in spite of the declamations of the physicians, who in vain assured the people that it was not adapted to the inhabitants of temperate climates; but it was almost entirely unknown in Paris.

We only know that during the reign of Louis XIII, a decoction, probably of coffee, under the name of "Cohové" or "Cahovet" was sold in the Petit Chatelet. But in 1662, no public coffee-houses had yet been opened in Paris, and generally speaking coffee can not be said to have been popularized until the middle of the eighteenth century.

Soliman Aga, who was Turkish Embassador to Louis XIV, in 1669, was the first to introduce coffee into Paris; he gave it to a few people as an experiment and they afterwards continued taking it.

At first the coffee was sold at the high price of 40 crowns per pound, but this exhorbitant price was not maintained for any long time.

A few years after, in 1672, an Armenian called Pascal established a coffee-house in the Fair of Saint Germain; when the Fair was over, he transferred his establishment to the riverside in front of the Pont Neuf. But this coffee-house was nothing more than a place where a few foreigners and Knights of Malta met. Pascal shortly after left for London.

A Sicilian named Procopio brought back the fashion of coffee drinking. Following the example of Pascal, he first established his business at the Fair of Saint Germain, where he attracted good custom through the excellent quality of his beverage. In 1689, he left the Fair and established his coffee-house in front of the French Comedy Theatre.

Shortly after this, an Armenian called Maliban, opened a new coffee-house in the Rue de Buci, near the ball playing ground in the neighborhood of the Abbey of Saint Germain; from there he passed to the Rue de Feron, near Saint Sulpice, but very shortly afterwards returned to his original location. Finding himself obliged to leave for Holland on business, he transferred his coffee-house to his waiter Gregorio, who had recently arrived from Ispahan.

Several other small establishments had been successfully opened, and finally, a certain Stephen Alepo, opened an esta-

blishment in Paris which was elegantly fitted up with mirrors and marble tables. Nevertheless, the number of cafés was not sensibly increased, and there was nothing to indicate the very great popularity which this beverage would eventually attain.

Everybody knows of the celebrated expression of Mdme. Sevigné: "Racine will pass like coffee." But in spite of the declarations of the romancers, Racine is still considered as one of the first of the French poets, and in spite of its destractors, coffee has become a staple article of consumption.

The establishments which were afterwards opened, rivaled each other in the luxury of their fittings. People met there rather to hear the news of the day than with the object of drinking coffee. We may remind our readers, that the invention of newspapers and gazettes is due to the introduction of coffee in France. The highest dames of the aristocracy often stopped their coaches in front of the coffee-houses and drank the beverage in silver cups.

The great success attained by Stephen Alepo and Procopio, whose café was frequented by Voltaire, Piron, Fontenelle, Saintfoix, etc., who there criticised and discussed the new works in literature, decided certain speculators on opening different establishments of the same character. The Regency Café, situated on the square in front of the Palais Royal, attained a great celebrity on account of the chess players who frequented it. The number of spectators who frequented that place in order to see the play of Jean Jacque Rousseau was such, that the Lieutenant of Police was obliged to put a sentinel at the door of the house.

The establishments in which coffee was prepared continued to multiply insensibly. During the reign of Louis XV, more than 600 of these establishments existed; whilst today the number is simply immense and shows no tendency to diminish.

At the beginning of the eighteenth century, Arabia furnished Europe with all the coffee that it consumed. Tired of paying a

heavy tribute for this delicious fruit, the Europeans attempted to cultivate the tree which produces it.

But two great obstacles presented themselves to the success of their projects; the Arabs would not allow the trees to leave their country, and the attempts which were made to propagate the plant from seed, induced the opinion that the Arabs passed it through boiling water or dried it in an oven before selling, with the object of keeping the monopoly in their own hands. This error was discovered when the tree itself was brought from Batavia, as it was then found that the seed did not germinate unless it was sown shortly after being taken from the tree. A Frenchman had the honor of experimenting on the cultivation of coffee in a climate different from the one it had been hitherto cultivated in; in 1670 he sowed some in a garden near Dijon, with the result that the plants grew but did not prosper.

Nicolas Witsen, of Amsterdam, was the first in 1690 to transport some fresh berries, according to some, and a tree, according to others, from Mocha to Batavia. This experiment was entirely successful.

During the same year, the governor of Batavia sent a sedling coffee tree for the hot-houses of Amsterdam. A lieutenant of artillery called De Ressous who was a student of botany, carried another plant from Holland to France, which he presented to Louis XV. in the year 1712, who then sent it to the Jardin de Plants, where it produced flowers and fruit, but shortly after died. Another tree was soon after this, in the year 1714, sent by Brancas, the Burgomaster of Amsterdam, as a present to Louis XV.

From this seedling which was cultivated in the Jardin de Plantes of Paris, under the care of Jousieu, originated the coffee trees which are cultivated in the West Indies and in almost all America.

In the year 1716, some plants which had been propagated from the seeds of the tree in the Jardin de Plantes, were confi-

ded to a physician called Isambert, for transportation to the French colonies, but the Doctor having died before fulfilling his commission, this attempt did not succeed in the desired object.

In 1723, another physician called de Chirac, gave a coffee plant to de Clieux, a Norman gentleman, with the object of its being taken to Martinique. The voyage was long and dangerous, and the supply of water got so small that it was only distributed in small rations, But de Clieux, who comprehended the importance of propagating this fruit in the American colonies, and desired to preserve a source of wealth to his country, divided his rations of water with the object of his commission, and finally had the happiness of landing it in Martinique in a weak, but not desperate condition. His care was then redoubled, he planted it in his garden and in the most favorable spot for its development, planting a hedge of thorn around it and putting a man to watch it continnually. The first year, he had the happiness of collecting two pounds of berries. Of these he gave a few to Guarigue, a coronel of the militia of Matinique, and to several inhabitants of the Island, who sowed them in their gardens.

By a sworn declaration, dated the 22nd of February, 1726, Blondel Jouvencourt, proved the existence in the gardens of Survillier, in the Parish of Santa Maria, of several coffee trees, amongst which were nine above twenty months old; in the same year, we have proof of the existence in Martinique of two hundred trees loaded with flower and fruit, of more than two thousand in a minor stage, and of a large number of others which were only showing above ground. Father Labat, to whom Survillier forwarded this declaration, relates in his work that the nine trees above mentioned produced forty-one ponnds of coffee in one year, without counting over a thousand berries that were given away for seed, and others that were stolen.

The coffee tree prospered in Martinique and the crops had already acquired some importance, when on the 7th of No-

vember, 1727, a terrible earthquake that lasted many days and that shook the foundations of the mountains, killed off all the cocoa trees which formed the principle wealth of the Island, and reduced the greater part of its inhabitants to a state of little above pauperism.

This horrible catastrophe resulted in great benefit to coffee and encouraged its cultivation in Martinique. The colonists entered into this new cultivation which such perseverence and zeal, that this Island alone produced all the coffee required for the consumption of France.

Without the precious gift of its benefactor, de Clieux, the colony once it was deprived of all resources, by the destruction of the cocoa plantations, would have been completely ruined; and yet de Clieux after having enriched Martinique with this new and important branch of industry, died poor and unknown in 1775 at the age of 97 years.

In 1804, de Laussat, Prefect of the colony, proposed the raising of a monument on the spot where this benefactor had planted his first tree, which was the object of so much solitude and the source of wealth to the Island, but this project was never carried out, because the Island of Martinique was taken by the English in 1809. But if no monument has ever been erected in honor of this traveller, says Tussac in his "Flora de las Antillas," the name of de Clieux must always live in the hearts of the colonists.

From Martinique a few trees were taken to Santo Domingo, Guadalupe and other neighboring islands. Some authors claim that coffee trees were transported to Santo Domingo as early as 1715.

The cultivation of coffee was rapidly developed in Guadalupe, though it is now neglected for the cultivation of sugar-cane.

After the year 1718, the Dutch very successfully cultivated coffee in Surinam, a District of Dutch Guyana. A criminal called Mousgues, escaped from French Guyana, but desirous of

returning to that country, wrote from Surinam to Lamotte Aigron, the Lieutenant of the King in Cayenne, offering as exchange for a pardon to risk the heavy penalties to which he would be liable if discovered, and take from Surmam some seeds of coffee in fit condition to germinate. Having received the promise of pardon, he returned to Cayenne in 1772, bringing with him a pound of coffee beans recently picked of the trees, and which he delivered to the Commissary of Marine, d'Albion, who had the berries sowed. These seeds duly sprouted and through them the colony was very shortly covered with plantations.

In 1717 or 1718 the French Company of the Indies, which was established in Paris, sent a few seedling trees of Mocha coffee to the Isle de Bourbon, now called the Isle de Reunion, by a ship captain from St. Malo, called Dufougeret-Grenier.

These plants were delivered to the Royal Lieutenant of that Island, Desforges-Boucher. In 1720 only one of these trees was living, but it produced so much that year that not less than 15,000 berries were picked. All the coffee trees now cultivated on the Island descend from these plants and produce the berry that in commerce is known under the name of Bourbon coffee.

The Island of Bourbon did not begin to export coffee to the markets until the year 1726. It is asserted that a species of indigenous coffee is found on that Island.

Some authors relate, that the inhabitants of Bourbon, having seen a few branches of an ordinary coffee tree with its leaves and fruit on board a French ship returning from Mocha, recognized the plant at once as similar to some trees which they had in their own mountains, and after a little hunting, brought down some branches which were found exactly similar to those on board the ship. At the same time, the berry of the Island was found to be longer, narrower and a little greener than that of Arabia.

The introduction of coffee into Jamaica, one of the most im-

portant of the West India Islands in relation to this valuable production, is said to have taken place in the year 1728 and is attributed to Nicholas Laws. The prèmature death of Laws, which took place three years after the introduction of the plant, seriously prejudiced this important enterprise, but the interest displayed by the colonists fully compensated for the loss of that distinguished philanthropist. In order to protect the development of coffee culture, the principal merchants of Jamaica petitioned the British Government to grant a rebate on the duties levied on the coffee imported from the Island into Great Britain.

This petition having been granted and the consumption thereby increased, the cultivation of coffee in Jamaica became such a lucrative business, that it very soon assumed large proportions.

The introduction of the coffee tree into the Spanish colonies took place in the year 1748. Don Juan Antonio Gelabert introduced it into Cuba about that period, although there are authors who assert that it was introduced in San Juan de Puerto Rico in 1769 by some French immigrants.

It is very probable that coffee was introduced into Mexico from the West India Islands towards the end of the last century, as in some statistics which were published with respect to the "Domestic and Foreign Trade of Mexico," by Don Miguel Lerdo de Tejada, amongst the products exported through the Port of Veracruz during the years 1802, 1803 and 1805, coffee figures in the proportions of 272, 493 and 336 quintals respectively.

The coffee which was produced at that period was most likely cultivated in Córdoba, which is believed to have been the first place in the Republic where it was cultivated, although in the opinion of respectable authorities, the cultivation of coffee was introduced in Córdoba in the year 1817 by Don Juan Antonio Gomez, who propagated it with the greatest care, and is

generally though to have been the original cultivator of this productive plant in Mexico.

We are of opinion that coffee was introduced in our country before the beginning of the present century.

The high price obtained for coffee from the West India Islands in the principal markets, and the easy cultivation of the plant in the neighborhood of Córdoba, determined our own agriculturists in the beginning of this century, to undertake its cultivation, the first results being those above shown.

The disorders brought about by the war of Independence and by the emancipation of the slaves, naturally disturbed the development of this industry, which was abandoned until the year 1817 when Don Juan Antonio Gomez revived and gave it a considerable impetus.

In fact, in the work that we have mentioned above, it is shown that in the years following 1805, no coffee was exported until 1825 and 1826, when the respective exportations amounted to 33 and 20 quintals respectively. According to the opinion of the Engineer, M. Ponce de Leon, 500,000 trees existed in Córdoba in 1826, producing a berry superior to that of Cuba.

From Córdoba the cultivation of coffee was extended to the adjacent districts, and occupied a great part of the Gulf Coast.

On the Pacific Coast this important cultivation has had another origin. In 1828 the illustrious General Michelena returned from London bringing with him a small quantity of coffee seed from Mocha. These seeds were planted in his estate of Parota, in the District of Ario, and there produced the plants that later on were propagated in Uruapan, the rest of the coffee zone of Michoacan and probably in Colima, where it was introduced by Don Ignacio Ochoa.

The coffee which is cultivated in the State of Chiapas, originally proceeded from Guatemala, as in 1847 Señor Manchinelli, of Italian origin, imported a few trees from San Pablo de Gua-

temala, which he planted in the lands of Chacara, District of Tuxtla Chico.

The cultivation of coffee in Oaxaca dates from very recent times. In consequence of the discovery of aniline dyes, the principal wealth of the State, which consisted of cochineal, received a serious blow, which almost led to its entire abandonment. Don Manuel Posada and other agriculturists in their turn, dedicated themselves to the cultivation of coffee with such great succes, that they very soon forgot their losses in cochineal.

BOTANICAL DESCRIPTION.

The coffee plant is a native of Arabia Feliz and Ethiopia, but is extensively cultivated in Asia and America. It is an ever–

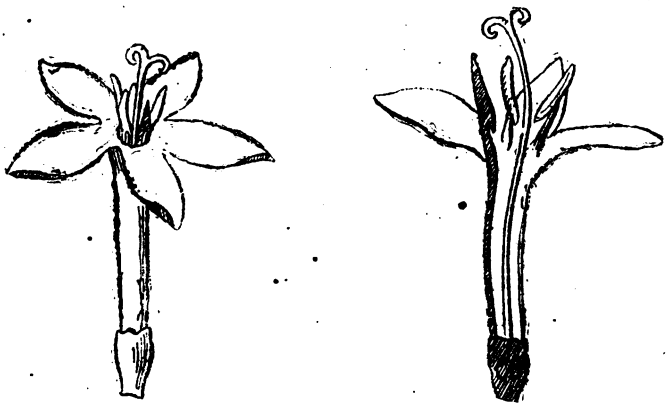


Fig. 1.

Fig. 2.

COFFEE FLOWER AND FRUIT.

green shrub from fifteen to twenty feet high, with oblongovate, acuminate, smooth leaves, a five-toothed calyx, a white tubular corolla, with a five-parted spreading limb, five stamina, one pistil with a bifid style, and an oval, succulent, blackish-red or purplish two-seeded berry. The seeds are inclosed in a membranous endocarp (the parchment-like putamen of some botanists) and consists of a horny, yellow, bluish or greenish albumen, which is on one side flat, with a longitudinal furrow, on the other, convex. At one end of the seed is the embryo, with its cordiform cotyledons.

The varieties of coffee are distinguished in commerce according to their places of growth; but considered with reference to their physical properties, they are characterized by colour (yellow, bluish or greenish) and size (the smallest seeds are about three lines long and two broad, the largest, five lines long and two lines and a half broad). Arabian or Mocha coffee is small, and dark yellow. Java and East India (Malabar) kinds are larger, and paler yellow. The Ceylon is more analogous to the West India kinds (Jamaica, Berbice, Demerara, Dominica, Barbadoes, etc.), which, as well as the Brazilian, have a bluish or greenish gray tint. Mexican coffee is of the same class as that from the West India Islands.

Many kinds of Coffeaceas are described and some of them cultivated; but the principal species and the one which is most cultivated, is undoubtedly the Coffea Arabica, whose name also shows its origin. This species has developed into a large number of varieties which are cultivated in many parts of the world, the most esteemed being called Mocha, which grows in Yemen and is considered, though perhaps without reason, to be the best in the world. In this country, if we are to believe tradition, some sub-varieties of the Mocha plant are to be found, and their delicious flavor appears to confirm the tradition.

The myrtle variety is generally considered as of second class, and is distinguished from the former by its lengthened leaf and

by the smallness of the tube in the corolla. It is the same variety as that which is cultivated in Java and Sumatra, is very abundant in the West Indies, and is probably the same variety that is cultivated in Venezuela, Central America and the greater part of this Republic. The *Bastard* variety is very much cultivated in Brazil and although it is not so much appreciated as those already mentioned, it has the advantage of being more thrifty and productive.

Fig. 3.

FRUCTIFEROUS BRANCH OF A COFFEE TREE.

The varieties which are called Edem and Bastard, and are cultivated in the Island of Reunion, are of an inferior class and

have no right to the importance that has been claimed for them.

In Brazil they cultivate, although on a small scale, a sub-variety which is known under the name of *Maragogica*, but it is of very slight importance. Besides the Coffea Arabica, mention ought to be made of the species called *Racemosa*, *Laurinea* and *Liberiana*.

The first of these has developed some varieties which are cultivated in Peru. The second, which was imported from the coast of Africa at the beginning of the present century, has given birth to a very thrifty tree which is now cultivated in the Island of Reunion, where it is known as the "Le Roy," that being the name of the ship captain who introduced it into the Island. The third, which is a native of Liberia, is stronger, requires less attention and is perhaps more productive, although the attempts to propagate it in Mexico have been unsuccessful. We consider it preferable to improve the varieties which we already have before introducing others whose success might be doubtful.

CHEMICAL COMPOSITION.

A great number of chemists have studied the composition of coffee. With more or less succes, Lefevre, Bourdelin Geoffroy, Guindet, Robiquet, Payen and others, have at different periods analized this berry, and though their studies were crude at first, they have in course of time been perfected until they are now on a par with the chemical knowledge of the present day.

It would be useless to relate all the different analysis that have been made of coffee by the learned chemists we have mentioned; it will be enough for our purpose merely to give the last results obtained, as well as some of the properties of the alkaloid which it contains.

According to Payen, a hundred parts of coffee contain:

Legumina, cafeine, etc.	10.000
Free Cafeine	0.800
Azote	3.000
Fatty substances	13.000
Glucose, dextrine and undetermined vegetable acid	15.500
Chloroginate of potash and cafeine	5.000
Insoluble essential oil	0.001
Soluble aromatic essence	0.002
Celulose	34.000
Mineral substances	6.907
Water	12.000
	100.000

The mineral substances principally contained in coffee, are potash, soda, lime, magnesia, oxide of iron, sulphuric and phosphoric acid, etc.

Graham, Stenhouse & Campbell have found the ashes of coffee to be composed as follows:

Potash	55.10	54.00	53.20	53.72	51.52
Lime	4.10	4.11	4.61	6.16	5.87
Magnesia	8.42	8.20	8.66	8.37	8.87
Phosphoric acid	10.36	11.05	10.80	11.13	10.15
Sulphuric ,,	3.62	3.49	3.82	3.10	5.26
Carbonic ,,	17.47	18.13	16.84	16.54	16.98
Chlorine	1.11	0.26	1.00	0.72	0.59
Oxide of iron	0.45	0.73	0.68	0.44	0.44
Total	100.63	99.97	96.06	100.18	99.68

The analysis of coffee which have been carried out in the Agricultural Station of Pointe-á-Pitre by M. Ph. Boname and which are of great scientific importance, have given the following results:

By the ordinary systems of treatment a hundred kilograms of fresh berries give 31.9 kilograms of parchment coffee, which in their turn produce 25.7 kilograms of clean coffee. The berry therefore contains the following:

Clean coffee	25.70
Parchment	6.20
Pulp	68.10
	100.00

Observations which have been recently made (March, 1894) in the coffee plantation of the "Union Iberica" in the district of Cuicatlán, Oaxaca, with respect to the proportion of pulp and seed contained in a ripe berry, allow us to present the following analysis, which will be of importance as special data for Mexico, as it perfectly agrees with the results obtained in the coffee regions of Colima.

100 parts of fresh berries contain by weight:

Clean coffee	20.00
Parchment	5.00
Gum and water	35.00
Pulp	40.00
Total	100.00

The different parts of the fruit consist of:

	Dry matter.	Water.
Fresh ripe berries	37.76	62.24
Fresh pulp	22.20	77.80
Clean coffee	81.10	18.90
Dry parchment	86.00	14.00

100 parts of dry matter contain:

	Ashes.	Azote.
Berries	3.82	1.65
Pulp	6.79	1.47
Coffee	3.69	2.08
Parchment	1.15	0.48

100 parts of natural matter contain:

	Ashes.	Azote.
Berries	1.44	0.61
Pulp	1.50	0.32
Coffee	2.99	1.68
Parchment	0.92	0.38

	Composition of the ashes of entire berries.	Ashes of 100 kilograms of berries.	Ashes of 388 kilograms of berries, containing 106 kilograms of coffee.
Phosphoric acid	7.11	0.1024	0.3974
Sulphuric ,,	2.96	0.0426	0.1652
Chlorine	1.30	0.0187	0.0728
Lime	8.67	0.1249	0.4846
Magnesia	6.25	0.0900	0.3492
Potash	51.40	0.7402	2.8720
Soda	1.86	0.0268	0.1040
Oxide of iron	0.70	0.0101	0.0398
Silica and sand (?)	1.19	0.0171	0.0663
Carbonic acid	18.56	0.2672	1.0368
Mineral matter		1.4400	5.5872
Azote		0.6200	2.3756

The following table shows:

1st. The elements contained in 3.880 kilograms of rough berries, and

2nd. The elements exported in 1,000 kilograms of clean coffee.

	3800 kilograms of coffee.	1000 kilograms of clean coffee.	Residuum in pulp and parchment.
Phosphoric acid	3.974 k	2.897 k	1.077 k
Sulphuric ,,	1.652	0.490	1.162
Chlorine	0.728	0.212	0.516
Lime	4.846	1.486	3.360
Magnesia	3.492	2.299	1.193
Potash	2.720	14.441	14.279
Azote	23.856	16.800	7.026

It is, therefore, seen that the coffee tree is a special consumer of potash, azote and phosphoric acid, an information which is very important to guide the agriculturist in the employment of manures.

Coffee principally owes its special properties to *cafeine*, a substance which was discovered by Runge in 1820, and identified with *theine* in 1838 by Jobst and Mulder. Cafeine can be

obtained by exhausting the coffee through hot water which dissolves the cafeine in small quantities of Malic acid and acid Malate. The Malic acid and Malates are precipitated by acetate of lead, and after filtering the liquid, the excess of acetate is eliminated by means of sulphurated hydrogen. After concentration the cafeine is obtained in the condition of needles. (M. Robiquet and Boutron).

Cafeine can be purified by cristalization in ether.

Coffee contains from 2 to 5 per cent of cafeine, combined with potash and chloroginic acid.

Cafeine can also be obtained by saturating the free acids in an infusion of carbonate of soda and precipitating the liquor by an infusion of nutgall. The tannate of cafeine is deposited and then dried, it is then mixed with powdered lime and dissolved in alcohol. The alcoholic liquid is then distilled and the residue purified by cristalization in ether.

Cafeine can also be obtained by sublimation, although according to Heynsius, this method is defective, because a part of the cafeine is destroyed by the heat. It has a slightly bitter taste, melting at 178° and is sublimated at 185°. It is soluble in cold water or alcohol, and is less soluble in ether. Crystalized in alcohol or ether, it is an anhydrite. Its density is from 1.23 to 19° C.

Solubility of cafeine according to Comaille.

Choloform.....	.....	12.97	.....	19.02
Alcohol at 85°.....	2.51	2.30	.....	.....
Water.....	1.47	1.35	49.73	.....
Absolute alcohol.....	.....	0.61	.....	3.12
Ether	.....	0.0437	.....	0.86
Sulphuret of carbon.....	.....	0.0385	.....	0.454
Essence of petroleum....	.....	0.025	.....	.....

According to Strecker, it fuses betwen 234° and 235°.

Under the action of heat, cafeine gives out metylamine when in the presence of an organic acid capable of supplying hydro-

gen, or when it is boiled with potash or hydrate of baryta. In this last case, it forms a new alkali, called cafeidine.

When subjected to the action of boiling azotic acid, it gives forth nitrous vapors and produces a yellowish liquid which takes on a purple tint, by the addition of a small quantity of ammonia.

The action of chlorine on cafeine, produces the same compositions as those which result from the action of uric acid under the same circumstances.

When the proportion of chlorine is not considerable, the principal results are amalic acid, metymamine, chloride of cyanogen and chloro–cafeine.

Heated with hydro–chloric acid and a solution of chlorate of potash, it produces alloxan, or a similar composition which stains the skin red.

Cafeine is distinguished from morphine, piperine, quinine and cinchonine by the fact that when heated with lime and soda, it gives forth ammonia and leaves a mixture of potassic carbonate, sodic carbonate and cyanide of sodium.

Besides cafeine, coffee contains other special substances, such as cafeic acid and cafetannic or chloroginic acid, both discovered and described by Pfaff in 1868, and afterwards studied by Rochleder and Hlasiwetz.

The cafetannic acid exists in the berry in combination with potash and cafeine, forming part of the cafetannate or chloroginate of potash and cafeine.

In the toasting process which coffee undergoes for the preparation of the ordinary berry, a great number of substances are produced, which as yet have not been thoroughly examined. Without doubt the most interesting is the aromatic principle, which has received the name of Cafeone.

Boutron and Fremy recommend the following method to obtain this substance: A sufficient quantity of water is distilled containing three or four kilograms of toasted coffee, obtaining in this way an aromatic liquor, which on being agitated with

ether, cedes to the latter a brown oil, which is heavier than water, and which is very slightly soluble in water. This oil is cafeone.

CLIMATE.

The coffee tree requires a hot and damp climate for its perfect development. Being a native of the hot regions of Africa, this tree can only attain its full development in those places which have a temperature sufficiently elevated to preserve the heat necessary to its vegetable functions.

The action of heat on vegetation is perfectly well understood. It determines the evolution of the germs by bringing their vital energy into play within certain limits, and in connection with the humidity, it encourages the flowering and fruit bearing properties of the tree; but in order that the influence of these elements should be efficacious, it is necessary that they be maintained within certain specific limits.

In this way, an elevated temperature facilitates the absorption by the roots and the evaporation through the leaves, it secures and accelerates flowering, as well as the inoculation and ripening of the fruit.

On the other hand, a cold temperature produces the opposite results, diminishing the functions of each and every one of the organs, besides deadening and even suspending vegetation.

A high temperature will also exercise an influence of different kinds on vegetation; when it is accompanied by a high degree of dryness in the soil and the atmosphere, it at once withers the green parts of the vegetables by provoking on the surface of all their organs, a rapid evaporation which the roots cannot counterbalance by an equally rapid absorption: should the same conditions last for any time, and should the heat still continue, the leaves fall, the vegetable funtions are suspended and the plant is overcome by weakness and gradually dries up.

The exterior parts of the trunk which form the residence of vegetable life, shortly after dry up and the tree dies.

When an elevated temperature is happily combined with a proportionate degree of humidity, extraordinary effects are observed. All the functions of the vegetable proceed with great rapidity, the nutrition is more secure and the plant is covered with leaves until they even prevent it from flowering, and thereby produce a loss of fruit.

Nevertheless, the effects of a high temperature are not as bad as they might be, because the same cause promotes activity in the circulation of the nutritive liquids, and as these proceed from the soil, which always has a lower temperature than the atmosphere, they tend to diminish the action of the heat on the green parts of the plant.

The nature of the soil and the depth to which the roots penetrate, have also a certain influence in counteracting the heat.

The vegetables whose roots penetrate to greater depths in the soil, suffer less under excessive heat, because during the summer, the temperature is lower in proportion to the depth to which they penetrate.

The soils of a calcareous nature, and with a light color, absorb very little heat and thereby diminish its injurious action, whilst the silicious sands and black soils favor the action of a high temperature.

When the temperature gets below zero, the nutritious liquids contained in the ducts of the vegetable, are congealed and thereby increased in volume; this increase in volume bursts the ducts and produces a change in the histological structure of the plant, as well as in the condition of its whole system, that ordinarily results in its death or serious disease.

Attention ought to be given to this effect produced by cold, as this is the way it operates in killing the blossoms which have already opened, whenever a heavy frost appears in the first days of spring or last days of winter. At the same time, the influence of great cold is not equal in all vegetables.

The plants which abound in nutrituve liquids suffer more seriously from cold, because as we have already stated, the temperature does not act on the woody parts, but on the liquids contained in the sap vessels.

On the other hand, other circumstances being equal, the cold has a more remarkable action on the vegetables whose sap is liquid than on those in which it is thick.

Experiments carried out by Blagden, demonstrate that viscous liquids, such as sap, congeal at a lower temperature than pure water and there are many well known experiments which demonstrate that liquids are difficult to congeal, when they are enclosed in capillary tissues. The influence of intense cold is commonly injurious to vegetable life, but the same can also be said of excessive heat.

The plant that we are now treating of, is one of those which require an elevated temperature for its development. The degree that is usually considered indispensable for its full development, is a mean temperature of 22° to 26° C.

It must be borne in mind, that the mean temperature of a locality is not an exact indication of its climate, as it is well known that the places wich have a mean temperature equal to that above indicated, will nevertheless have a maximum of temperature extremely different from this. The isothermal lines which have been laid down by Humboldt and other observers and which we find on climatological charts, only indicate the mean temperature of the localities through which they pass and do not give the information required for agricultural and climatological purposes, thus creating a necessity for the determination of lines of maximum and minimum temperatures.

In this case, as well as in almost all studies referring to agriculture, the maximum and minimum temperatures of a locality are what students most require to learn, because as we have already shown, it is necessary to ascertain if the extremes of temperature in the locality, can be supported by the plant which it is desired to cultivate.

The coffee tree, which can support the greatest heat without any sensible injury, is extremely sensitive to cold, and for this reason, care must be taken that the minimum temperature of the locality does not descend beyond certain limits; 12° can be supported by this tree, and that is the temperature which can be looked upon as a minimum. At the same time, it is difficult to enter upon thermometrical observations which require minute and constant attention, when we are treating of the establishment of an agricultural enterprise.

There are many circumstances that have a marked influence on temperature, and which being easy to discover, will give a very good approximate idea of the desired information.

The principal circumstances which decide the temperature of a locality are the followiug:

Latitude: On account of the position that our planet occupies with respect to the sun, the amount of heat which we receive and which is the life of all vegetation, is very unequally divided. The regions situated in the neighborhood of the equator are those which receive the maximum of heat, and the species that there vegetate, are those which require a greater amount of solar heat for the maintenance of their vegetable life, whilst in the neighbordood of the poles where very little solar heat is received, the vegetation is scanty, weak and finally impossible.

Between these two extremes, we find the localities whose temperature is adapted to the cultivation of all classes of vegetables, and as the latitude ascends from the equator towards the poles, the temperature descends and the vegetation changes.

The coffee tree cannot be developed above certain latitudes; in the equator, the excessive heat injures its production, and its cultivation is therefore unprofitable, whilst outside of the tropics, it is very difficult to cultivate, as the plant does not find the heat which is necessary to its life. The zones which

are productive of coffee, are found between 4° and 26° of North or South Latitude.

Altitude: If the surface of the globe were perfectly level, nothing more than a knowledge of the latitude would be required to show what localities were adapted to the cultivation of coffee; but besides the latitude, the elevation has a great influence on the temperature. The higher the elevation of a locality, the colder is its climate.

In ascending high mountains, the same decrease of temperature is observed as in travelling from the equator towards the poles, and at high elevations we find a region where even under the equator, the snow becomes perpetual.

For this reason, we can find vegetables of all climates in tropical countries: in the neighborhood of the coast or at a slight elevation above the sea, the vegetation is commonly that which belongs to the torrid zone, the heat and humidity are considerable, but in proportion as we increase the elevation, the vegetation changes; we first meet the vegetable species of the temperate zone, then those of the cold countries, and lastly, at a considerable altitude, we only find the vegetation of the polar regions, similar to that of Greenland and Lapland. Through its special configuration, our country is happily endowed with a variety of climates which allow the earth to produce fruits belonging to all parts of the world.

The Northern part of the Republic being situated outside o the tropics, is temperate and produces the vegetation proper to that zone. The Southern part which lies between 14°–30′ and 20°–30′ of North Latitude, may justly be called a hot country. The Sierra Madre which forms the boundary of the great Central Table–land, spreads out towards the coasts in slopes of more or less extent, and as these have a great variation of altitude, they produce an extraordinary variety of vegetation.

For this reason, we find tropical products up to an elevation of 1550 metres, above which the banana tree gives no fruit. On the great Central Table–land, all the products of the tem-

perate zone are found in abundance, whilst in the Northern part of the Republic, the vine is capable of producing excellent wines.

A reasonable combination of latitude and elevation, will show the localities adapted to the cultivation of coffee. Within the ample zone of latitude, which has been found indispensable to the cultivation of this plant, places are found which are more adapted than others to such cultivation, and the explanation of this phenomenon is to be found in their respective altitudes. Not all the places which are found within the torrid zone are adapted to the development of the coffee tree. The low elevations in the neighborhood of the coasts, are often adapted to this cultivation when the heat is not excessive.

At higher elevations than 1,000 metres, even if the coffee tree develops, it does not produce enough to render its cultivation profitable.[1] The coffee producing zone is situated below this altitude, as a rule, the most convenient having been found at an elevation of 800 to 900 metres. It appears that at these altitudes, the highest production is obtained, and that it diminishes in proportion to the distance from them.

The District of Córdoba, which is one of the best for the cultivation of coffee in this country, is situated, more or less, between 800 to 900 metres above the level of the sea.

Another important question in the selection of locality, is in the exposure that it has. In the Northern Hemisphere a Southern exposure is a great deal the warmest; when it is desired to take advantage of a great heat as in this case, it is always convenient to acquire, as far as possible, a Southern exposure; it may happen that in very hot climates such an exposure would be slightly injurious to the coffee tree, in which case, it is better to procure an Eastern exposure, but under any circumstances, it is always desirable to avoid a Northern exposure, which especially in winter, is injurious to the coffee tree.

1 Nevertheless there are many productive localities above 1,000 metres.

We have here given a general idea of the conditions of temperature required for the full development of the coffee tree. A full knowledge of these conditions is of the greatest importance for the cultivation of the plant we treat of, but another important question is that of the hygrometric condition of the atmosphere.

A greater or less quantity of water is always found in the atmosphere in the condition of vapor, and according to the experiments made by Bousingault, a part of this is absorbed by the leaves, which thus assist the roots in their functions and contribute to the reparation of the losses suffered by evaporation. If the atmospheric humidity is beneficial within certain limits, it is not so when it becomes excessive, as it then results in injury to vegetation. We thus find that when the temperature lowers, the vapors are condensed in the form of fog, and if that phenomenon should be repeated for several consecutive days during the flowering season, many of the newly formed fruits fall off with a great decrease in the product of the tree. When the temperature is lowered very considerably, the water in the atmosphere may congeal and then the injuries suffered by the trees are very great.

Beyond these risks, which on the other hand are not very much to be feared within the districts where coffee is commonly cultivated, the humidity in the atmosphere is beneficial and even indispensable for obtaining the best results. We have already indicated the functions of atmospheric humidity in hot climates; without this humidity, the ardent rays of a tropical sun would not only be injurious, but would absolutely prevent vegetation. Aside from evaporation, which is very great in certain parts, the rains are charged with the task of preserving the necessary amount of humidity.

As the temperature, and perhaps still more, the amount and frequency of the rains vary through a great number of causes: there are places which are only irrigated by an occasional storm, and whose only humidity proceeds from the constant evapora-

tion of the liquid surfaces or from the beneficent action of overflows from the rivers, and we have a striking example of this in the wealth derived from the overflow of the Nile over the low lands of Egypt, which from time immemorial have saved that country from becoming a part of the Desert of Sahara.

Within the tropical zone, the rains principally depend on the solar changes. In passing over the zenith, it causes a continuous upward current of air which produces atmospheric movements, and brings the lower and higher latitudes into connection, establishing an equilibrium between their different temperatures. The regions which are more directly under the rays of the sun and which therefore, are the hottest, receive the cool breezes from the North and the South, whilst in the upper regions of the atmosphere, the contrary currents place the hot lands in communication with the colder zones. The upward current which is produced by the passage of the sun over the zenith, also produces a calm zone on the surface of the sea, and on the surface of the continents, it produces a zone in which the heat reaches a maximum with a minimum of atmospheric pressure. Within the zone bounded by the tropics and which appears to be traversed by the sun, the passage of the latter over the zenith and the periodical movements of the atmospheric strata determine the periodical return of the rains. Within the tropics, the seasons of rain vary according to the centre of aspiration which follows the movement of the solstice in travelling from the equator. On meeting the ascending currents of that zone, the breezes ascend to higher regions and discharge the aqueous vapors with which they have been charged in passing the equator. The length of the rainy season is in relation to the latitude, that is to say; it is longer in those localities which are situated nearest to the equator, and shorter in those which are nearest to the tropics.

The mountains, which are the coldest parts of the continents, exercise a considerable influence in the precipitation of the rains, because their elevation allows the heated and humid at-

mospheric strata to come into contact with others of a different character, thus facilitating the condensation of the vapors. According to Dove, the condensation causes lateral currents to form which take possession of the aqueous vapors, the result being the inmediate formation of humidity in the place of meeting, whilst a drought is established in the spot where the precipitation took place. The presence of forests is also favorable to precipitation.

Grisebach believes that the forests act on the warm currents by cooling them, as the evaporation from the leaves produces a considerable cooling, which combined with the cooling of the soil that can not receive the rays of the sun through the abundant foliage, determines the cooling of the atmospheric currents with a high temperature, and consequently, the condensation of their vapors.

The action of the forests is perfectly demonstrated by the disturbances observed in the rainy season, in all countries which, like India and Brazil, have been subject to extensive devastations in their forests.

In the Mexican Republic and for many years past, the greatest absurdities have been committed by the unlimited cutting down of forests, absurdities that sooner or later will exercise an injurious influence on the duration and amount of the rains.

The thorough development of the coffee tree requires an abundance of humidity, but from what we have above stated, it will be understood that an excess would be almost as prejudicial as a scarcity.

Referring to the conditions of humidity which are required by the coffee tree in Southern India and Ceylon, E. C. P. Hull considers that the requirements of the case would be met by a rainfall of 100 inches, distributed throughout the twelve months of the year.[1]

There is a great want of observations, which would determine in an exact manner the amount of humidity required by

1 Page 39 of his work. London 1877.

the coffee tree, for which reason we limit our remarks to the fact that most of the places which combine the conditions of latitude, elevation and exposure as above stated, generally have an abundance of rain.

These explanations will have shown the reader that the coffee tree acquires its best development in hot and humid climates in which the latter characteristic is not excessive.

SOIL.

There is nothing more important to the agriculturist than a perfect knowledge of the soil which he is about to work, as it is greatly to his interest to procure the largest possible crops as a reward for his labor. The only means of production which is within his reach is the soil, because as regards climatological agencies, we have already shown that he can only select them in certain cases, but under no circumstances can be exercise any influence on them or modify them in his favor. He can do nothing to increase the rains or prevent frost; and in one word, as far as human knowledge now goes, he is absolutely impotent to introduce any modification in the atmospheric conditions.

The functions of the soil are not reduced, as was belleved for a long time, to serving as a mere stand for the plants; the studies which have been carried out on the absorbent functions of the roots, have brought to light the fact that the juices which are utilized in the creation of vegetable matter are absorbed from the earth; all vegetables take the greater part of the food which they require, from the earth immediately surrounding their roots, and as the substances which plants require to absorb for their nutrition, are almost always of the same character, the composition of lands for cultivation generally require to contain those same elements.

Nevertheless, the infinite variety that is observed in the

quantitative composition of the soil, results in the grouping of these elements in very different proportions, thus giving a special character to the soil and specially adapting it to the cultivation of different species.

All the components of the soil are commonly found combined in four principal bodies, which have received the name of agricultural elements; clay, sand, lime and humus. Each one of these elements has a distinct influence on the physical properties of the soil and on the vegetables themselves, so that these properties not being equally favorable to the development of every plant, it is necessary, in selecting land adapted to the cultivation of any given plant, to study the chemical composition of the soil and its adaptability to the desired crop.

The properties of these elements are in a certain manner communicated to the soil of which they form a part, so that when found in the necessary proportion, they establish a convenient equilibrium and constitute a soil adapted to the development of the different plants which it is desired to cultivate. A soil of this character is not to be found in all parts, but on the contrary, it is rare to find soils of such a well constituted character; in fact, the general rule is, to find soils which are not in that way adapted to the desired object, so that the agriculturist is obliged to select those which appear most advantageous. Such a selection ought to be the result of a careful study of the requirements of the plant and the properties of the soil, and we now propose to enter upon the discussion with respect to both these questions.

In common with all other vegetables, the coffee tree requires that the earth which serves it as a support, should contain the chemical elements which are necessary to the maintenance of its vegetable life, but it especially demands the presence of phosphoric acid, potash and azote, and therefore in selecting the land for its cultivation, it will be preferable to decide on that which contains the elements above mentioned, combined with other circumstances which we will mention further on.

The chemical analysis is a trustworthy guide which gives us a knowledge of the proportions in which these elements are found, and will be an important auxilliary to our investigation. By means of this analysis, we can arrive at a knowledge of the proportions in which phosphoric acid, potash and azote are contained in the soil, and will thus facilitate, and in may cases decide, the selection of the required locality, but as an analysis of this character requires time and special knowledge which is not within the reach of all agriculturists, we will now point out some of the conditions that ought to be found in the soil where it is proposed to cultivate the coffee tree.

As it is necessary that the soil should offer no resistance to the passage of the roots, it ought to be friable, but at the same time, with sufficient tenacity to support the vegetable and give it the stability required to resist the force of the wind. Air and water, which are indispensable to all vegetables, ought to penetrate the soil and reach the roots, for which purpose it ought to be sufficiently porous and of a character that would preserve its humidity. The working soil, that is to say; the arable strata, ought to be deep, as the root of the coffee tree penetrates to a considerable depth.

The soils that fulfill these conditions best are the sandy clays and ferruginous clays. The sandy clays are generally fertile and do not require any improvement, because the elements of earth, sand, clay and lime are found in almost equal proportions.

In Arabia the sandy clays are those preferred, and as a proof of his, we will quote what Lepelletier says with respect to the lands of Yemen: "The Arabs cultivate the coffee in soils of different classes, but that which they select for choice, is the clay soil mixed with sand, or with humus or disintegrated volcanic rock. In certain parts of Yemen, they prefer land which contains small rocks or boulders. Some Arabs assert that the coffee vegetates with more luxuriance on theses lands and the crop is of a better quality; but they are not all of the same opinion, and if they do not clear off the boulders, it is because h ey feel certain that they do no injury."

The ferruginous clays contain large quantities of oxide of iron. They are of a dark reddish or yellowish color, according to whether the oxide is found in the state of anhydrite or hydrite.

The other lands which contain oxide of iron in the condition of dydrate are entirely unadapted to cultivation, though very useful for the manufacture of bricks. On the contrary, the black or red earths which contain anhydrous oxide, are very well adapted to the cultivation of coffee which is perfectly developed wherever they are found; in the coffee growing zones of Brazil, the red and black-red earths are considered the best adapted for the cultivation of coffee. According to Van Delden Läerne, the cultivators of that country classify the coffee lands of a ferruginous clay character, as follows:

Terra vermelha (of granitic origin). A ferruginous clay with a dark color and containing a large proportion of iron.

Terra massapé (of granitic origin). A ferruginous clay of a red or copper color, containing less iron but more clay, potash and sandy quartz.

Terra roxa. A ferruginous clay with a bright red color, rich in iron and potash produced by the descomposition of diorite and abounding in feldspar and amphibole.

There is another variety of the massapé, which is called *terra salmorao*, that is different from the first in containing an abundance of fragments of quartz.

The planters consider the *terra roxa* as eminently adapted to the cultivation of coffee, giving the second place to the *salmorao*, which is very easy to work on account of its lightness.

During the experiments that were made in the District of Córdoba under the Engineer, José C. Segura, we had many opportunities of observing the kinds of soil which were preferred in that neighborhood for the cultivation of coffee. These soils contain a remarkable quantity of alumina, are rich in oxides of anhydric iron, and according to the analysis which we took of them, have a remarkable similarity to those of Brazil.

The above paragraphs will have shown what has otherwise been proved in practice, that the sandy and ferruginous clays are to be preferred for the cultivation of coffee.

At the same time, it must be borne in mind, that the very sandy clays are difficult to work, are not permeable to water and frequently become very dry; so that wherever possible, the intending planter ought to search for those soils which contain clay or ferruginous clay combined with a sufficient quantity of humus to counteract the effects of the clay.

For this reason the new lands which are covered with forest, are specially adapted to this cultivation, as they generally contain a considerable quantity of humus and of organic detritus.

With respect to this last point, the lands of Brazil are to a certain point defective, as they are often wanting in azotides. It is hardly necessary to repeat that the depth of soil is an indispensable condition, as the tap root of the plant penetrates to a great depth, and any interference with its development can only result in serious loss. We now give the results of an analysis of some soils from Brazil, which were made by Dr. Adolphus Mayer of the Agricultural Institute of Wageningen, as well as of other soils taken from Cuba, Martinique and the plantation of San Marcial in the neighborhood of Córdoba, Mexico.

Earth from Brazil.

Mechanical anlysis.

Fine clay	53.1
Sand	46.9
	100.0

Chemical analysis of the fine soil.

Lost by ignition	Part humus Part water	7.60

Soluble in dilute acid	Silicic acid	0.19
	Phosphoric acid	0.08
	Sulphuric acid	0 01
	Oxide of iron	4.08
	Aluminous earth	2.02
	Magnesia	traces.
	Alkali (potash)	0.04
	Soda	0.02
	Lime	0.24
Insoluble matters		85.62
Azote		0.03

Cuban soil adapted to coffee.

Fragments of lime, and vegetable refuse	0.2
Water and organic matters	25.9
Clay	50.6
Peroxide of iron	14.0
Oxide of manganese	1.0
Fine lime	8.0
	99.7

Soil from Martinique adapted to coffee.

	Soil.	Sub-soil.
Phosphoric acid	0.119	0.064
Lime	0.022	0 053
Azote	0.530	0.058
Alumina and oxide of iron	10.781	18.495
Potash	0.041	0.024

SOIL FROM SAN MARCIAL, CORDOBA.

Mechanical analysis.

Stones and organic detritus	0.810 gs.
Fine earth	499.190

Physico-chemical analysis.

Clay	51.220
Sand	35.000
Limestone	0.150
Water	9.000
Humus	4.630
	100.000

Chemical analysis.

Phosphoric acid, per hundred	0.0665
Potash	0.0738
Oxide of iron	3.0810

This analysis was carried out under the direction of the Engineer, Don José C. Segura, in the laboratory of the Institute of Córdoba, which was kindly placed at our disposal by Dr. Peña.

PREPARATION OF THE GROUND AND ARRANGEMENT OF THE PLANTATION.

The land which is intended for the establishment of a coffee plantation, ought to be properly prepared in order to attain the desired object. The manner of effecting this is different in every case, according to the special conditions of the locality.

There is no doubt that the good arrangement and careful preparation of the soil have a great influence on the success of the undertaking, and so much so, that it can be casily shown that failures in this important business, frequently arise from defects in these operations.

The good arrangement of the plantation is not only important for the better appearance it gives to the estate, but also for the other advantages which are not necessary to go into at present, and which relate to the facilities for working, and the economy of space, as well as of time and money.

Preparation of the ground: The land on which the plantation is to be established, must be conveniently prepared and laid off. The object of these operations is easily understood, the first being necessary to facilitate the development of the plant by surrounding it with favorable conditions, and facilitating its nutrition by an increase of substances which would come within reach of its roots; whilst the second is convenient for reasons of economy, seeing that a well arranged plantation facili-

tates all the operations necessary to the cultivation, rendering them more orderly, more exact and more economical.

A careful preparation of the soil brings good returns to the cultivator by increasing the production of the plants, which, deriving from the soil the nutritious principles which they afterwards transform into fruit, find a wider field for their development in well prepared soils which are easily penetrated by the roots, the principal organs of absorption.

Too much emphasis can never be given to the importance of preparing the earth for the subsequent success of the plantations, but unfortunately for our country, we do not give to this point all the attention that it deserves, and this kind of preparation is generally very much neglected.

It would be difficult to set down in a positive manner the exact character of the ploughing that ought to be given to the land before it is in a condition to receive the plants, as this undoubtedly varies in each particular case. A very great number of circumstances have to be taken into consideration in undertaking this work, and many of them are likely to be of an entirely local character. Nevertheless, the desired result can be easily attained by a study of the land about to be planted; the object of the cultivation being, to modify the physical, and to a certain extent, the chemical properties of the soil, that is to say; to facilitate the growth of the roots and place within their reach the largest possible supply of food, as well as to graduate the humidity and consistency of the soil.

These desired results can be obtained by the employment of the means within our reach, doing so with the necessary discretion combined with economy.

The employment of manures and cultivation, are the means by which the prudent cultivator assists the forces of nature. With respect to the first, we shall not enter into any extended discussion, as their use is determined by the nature of the soil and we now propose to discuss the latter operation.

As the primary object of the cultivation is to turn up the

soil, thereby softening and pulverizing it as far as possible, the ground is ploughed as often as may be necessary for that purpose, and to the depth required. On land that has already been cultivated and is of moderate fertility, it is usual to run the plough over twice and to a good depth, at the beginning of winter, leaving the ground in that condition for one or two months; after which it is harrowed as often as may be necessary to leave it completely turned over and pulverized.

The ground having been thoroughly turned up as above described, the holes are opened, in the manner that will be referred to farther on.

In the State of Oaxaca and others in the Republic, the topographical features of the country, the impenetrable character of the virgin forests and other circumstances, have obliged the planters to adopt other systems of preparing the soil than those which we have above shown. When it is proposed to establish a new coffee plantation in the unreclaimed lands to the South of the Republic, a commencement is made by cutting openings through the forests in different directions, with the object of selecting a convenient spot for the nurseries, offices, etc. For the location of the offices, it is best to select a level piece of ground with sufficient area to contain all the buildings. The nursery beds particularly require that the ground should be level, deep and rich. Once the site of the plantation is determined on, the planter proceeds to commence the work of clearing.

Clearing. The first stage in this work is commenced in the dry season, which in the tropical region generally commences in the month of December. This first stage of the work consists in cutting down all the underbrush and small vegetation which is in the tropical forest. This operation is followed by that of falling the large trees, carefully leaving a sufficient number of well selected trees to furnish shade for the plants. In this country the work of clearing is generally done with the ax, the Indians not having yet acquired the use of the saw. Nei-

ther are they accustomed to clear off the stumps which are generally left to rot on the ground. Once the trees are thus thrown, the branches are all cut to pieces and dragged outside of the forest.

The large trunks which can afford timber for the carpenters' work in the buildings are carried away, whilst those which cannot be utilized in this manner, are left lying in a position perpendicular to the slope of the ground. The planter now proceeds to lay out his plantation.

As we have already said, the best time for this work as well as for the ploughing, is at the beginning of winter; but that for harrowing must be adapted to the special condition of the ground, and very often subordinated to the period of the opening of holes for the trees.

This last operation ought to be carried out as long a time as possible before the transplanting of the trees, as it is of the greatest importance that the holes and the soil extracted from them should be subjected to atmospheric influences, and for that purpose, a period of one or two months ought to be allowed.

In this country the transplanting is generally done in the months of June and July, and therefore, the planter proceeds with the opening of the holes and planting of the banana trees, in the months of March and April. Before speaking of the way in which these holes ought to be opened, we will speak of the arrangement of the plantation and the distribution of these holes.

It will be at once understood, that the area, configuration, etc. of the estate will exercise a great influence on the distribution of the plants, which will also be affected by the special desires or convenience of the respective proprietors.

The arrangement that has been adopted by the greater part of the planters in this country, has been that of dividing the land into rectangular blocks of more or less area, which are separated by roads of sufficient width.

Most of the methods that we have seen adopted for the division of the land, are specially selected with a view to the physical configuration of the country. One of the best consists in dividing the land into rectangular figures with a length of 100 metres and a width of 60, leaving between each block a road of 5 metres width.

Within these blocks the trees are distributed in such a manner that they form isosceles triangles of 2 metres on each side, so that 3,000 plants can be put into each block.

This system of planting in triangles has great advantages over the rectangular system, because in the latter, besides having less trees on a given area, it has the disadvantage of only allowing four roads between the trees.

This brings us to the discussion of an important question: the distance to be alloweed between the trees. We have already said that they ought to be placed at a distance of 2 metres, which appears to us the most convenient, but it must be understood that we by no means lay this down as a rule to be adapted in all cases, as the degree of fertility of the soil will decide the question.

On a very fertile soil, a larger number of plants can be cultivated on a given area, on account of the abundance of nutritive elements, and therefore, the distances may be considerably lessened. On poor lands, the absence of these same elements, prevents our planting such a large number of trees on any given area, as the soil cannot find support for so many plants within a given space. In both cases, there are limits which ought not to be exceeded.

In the first case, the distance adopted ought never to be less than that which is required for the lateral development of the plant. In the second place, the above rule ought to be combined with the necessary economy of land.

The minimum distance to be adopted in very fertile soils, ought never to be less than 2 metres, and in no class of soil ought it to exceed 3.50 to 4 metres.

Having disposed of this question we will now indicate the proceeding necessary to open the holes for the plantation, on the supposition that the triangular form has been adopted. Lines are traced on the ground parallel to the longer sides of the block, in such a manner as to leave a distance between them of three-fifths of the distance determined upon (1.60 metres when this distance is fixed at 2 metres) (Fig. 4). Other

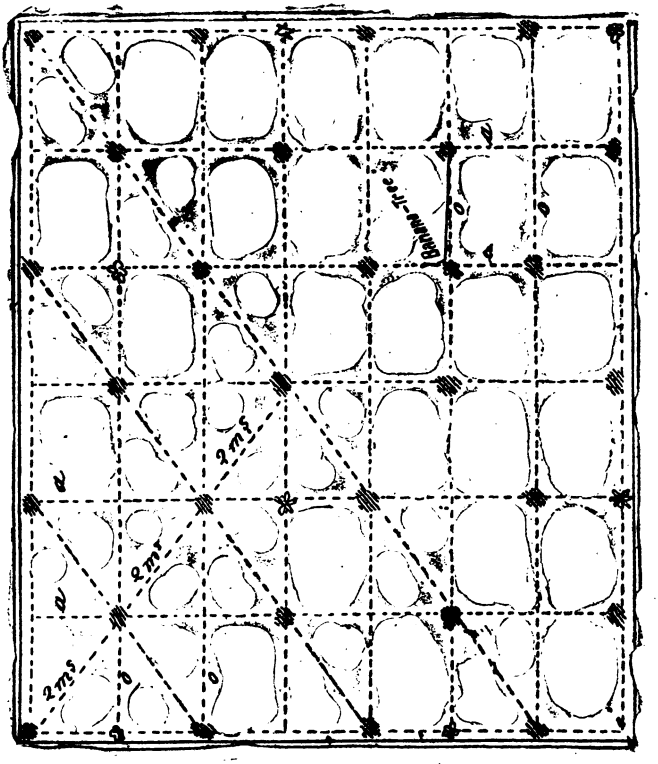


Fig. 4. ARRANGEMENT OF THE PLANTATION.

parallel lines are then traced at right angles to the former, with a distance between them of three-fifths of that determined on between the trees, and on tne alternate points of intersection of these lines, the holes are sunk, leaving the intermediate points untouched.

In Fig. 4, the lines *a* are those which are separated by four-fifths of the distance, and the lines *o* are those which are three-fifths of the distance apart, and at the points where these meet are situated the holes for the coffee trees.

In those places which are not adapted to the employment of the plow, either through the slope of the ground, the abundance of trunks or through any other circumstance, the laying out of the plantation is carried out in the following manner:

Staking. In order to show the points in which the stakes are to be placed, a rope is used, on which the desired distances are shown, this generally being done by knots. The laborers take the ends of this rope and stretch it along the line which is to be followed, the ends of these lines being shown by large stakes driven into the ground. Another laborer, who is provided with a sufficient number of stakes, goes along the rope leaving one standing wherever a knot appears. He is followed by another man who drives the stakes into the ground exactly in the place where they ought to be. Having terminated one length of the rope, the men stretch it afresh so as to lay off a new length, and in this manner, mark out the whole ground in the desired parallel lines.

By following this method, a plantation can also be laid out on the triangular system. In this case, the lines will be laid off at a distance equal to three-fifths of that which is desired between the trees, and the knots will be marked off on the cord with a distance between them of four-fifths of the distance which is to be left between the trees. Care must be taken to mark the alternate knots in some special manner, such as having a red rag on one and a white on the other. The stakes will then be set up in the following order: on the first line, they will be placed at all the white knots, and in the second at all the red knots, and the result will be that the plants will appear as shown in Fig. 4.

These points having been marked, square holes are dug with a width of 30 centimetres and a depth of 40 centimetres.

The planter is strongly recommonded to take the soil out in a systematic manner in order to return it by the same method. On some estates, care is taken to place the soil first extracted

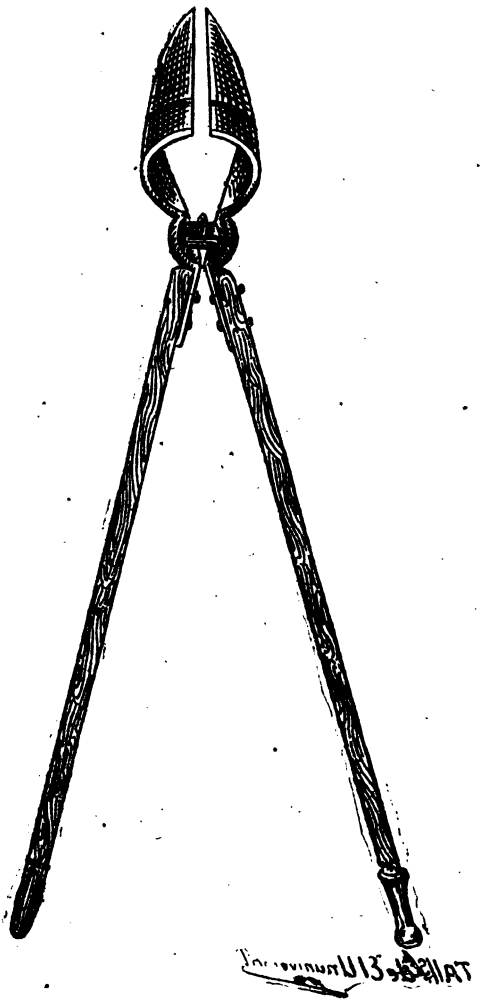


Fig. 5.

LITTLE GIANT.

to the right hand side of the laborer, the earth forming the second layer is placed in front of him, and the deepest to his left. In this manner, the hole is surrounded by loose earth on three sides, and when the tree is transplanted the filling up is very easily done. In order to sink the holes, the ordinary instruments of agriculture are employed, and the work is very simple, but in order to make it still easier, Mr. L. Rincon y Blanco recommends the employment of the American post hole digger, "The Little Giant" (Fig. 5), which is an implement composed of two shovels jointed on a bolt, and whose arrangement allows them to move on a vertical plane.

In Oaxaca they employ other instruments for this work of opening holes for the trees, being more specially adapted to the operation, and they are called "Barreton" and the "Tarpala."

The Barreton is particularly useful in breaking the roots that may be found in the earth, as well as for sinking the holes. It consists of an long iron blade with an axe edge set on to a wooden handle with a length of one metre.

The Tarpala consists of a broad blade sharpened at the lower end, and is used to extract the earth, the same as a shovel. This instrument is also employed in weeding the ground. The laborers in the South, who are accustomed to working with these instruments, manage them with dexterity and rapidity.

The sinking of the holes is done in March and April, at which time the banana trees are also set out.

As will be shown in the article treating of shade, the banana tree does not appear to us the best adapted for giving shade to the coffee tree, but we cannot do less than recommend its use in those cases in which the plantation cannot be given the benefit of a forest shade. In spite of the many disadvantages that it has, its rapid growth makes it the only tree that can be employed with advantage in the establishment of plantations in open ground.

The banana tree is propagated by means of suckers. Each

tree produces four or five suckers round the main trunk, which can be utilized for propagation. When these have attained the height of 1 metre or 1½ metres, they are taken out of the ground with a spade, the tuber is perfectly cleaned so as to leave it without any roots, as practical men believe that leaving them sours the tree and prevents its taking root, and it is then trimmed so as to leave only the heart, after which it is planted.

With respect to the distance at which these trees are to be planted, as well as other details, we will treat of them in another article relating to the question of shade.

The ground being thus prepared, the coffee seedlings can be transplanted in June and July.

SEED BEDS AND NURSERY BEDS.

Their importance.—Places adapted for their establishment.

The cultivation of woody plants, requires the selection of a convenient place adapted to their nature, so that they can be given the care they require during the first period ot their existence.

Nature reproduces its species with a freedom that cannot be artificially imitated, and if we take into consideration that the scope of the agriculturist is extremely limited, and that the demands of agriculture are very great whilst the economy of time and money is of consequence, we can easily understand how far he must necessarily be from imitating nature on this point.

Nature, which disposes of a an immense quantity of seed, of unlimited area of land, and has no special necessities with respect to distribution, fills its object by scattering these seeds on the surface of the soil so that they germinate and live with entire freedom.

Cultivated plants are subject to greater and better defined necessities; these plants must be arranged with regularity, must

be well distributed, must live under similarity of conditions and as far as possible, have a similarity of production; all of which are conditions that are difficult to attain by merely laying the seeds on the ground, as it is very seldom that they germinate under the same circumstances. On the other hand, it is difficult if not impossible, to give the plants that minute care which is demanded during the first period of their lives, and when they undoubtedly are more susceptible to injury. The coffee tree is an especially delicate plant and requires particular care during the first stage of its life.

The result is, that the propagation and education of the coffee tree requires to be carried out in nursery beds. If there finds a well prepared soil from which to derive the sustenance which is indispensable to its development, as the small areas which are dedicated to that object can be worked and prepared with greater care; each seed or plant can be placed in the most favorable conditions, and can be attended with all that care which its delicate condition claims and which could not be bestowed on large areas of ground.

Seed beds. Some planters advise the formation of seed beds apart from the nursery beds, and we believe that there is no disadvantage in this method, but still, in order to simplify the cultivation without neglecting the necessary precautions, we will relate the method followed by the planters of Guatemala for forming the seed bed in the same place as the nursery bed, and which we have found very useful in practice. Two advantages are obtained by following this method: first, the cultivation of only a part of the ground, a matter worth considering in some cases; and second, the more important advantage of avoiding the transplantation from the seed bed to the nursery bed, an operation, that besides entailing some expense, also presents some material difficulties, as we will show in treating of the question of transplanting.

Nursery beds. The most appropiate place for the situation of the nursery bed, as well as the area dedicated to it, depend

on the special circumstances of the locality and on the proposed extent of the plantation. In order to determine this point, the planter ought to bear in mind the cost of the work and of the transportation of the trees.

It is therefore advantageous to locate the nursery beds in such a manner that it will not be necessary to carry the trees any long distance at the time of transplanting, because this long journey, besides entailing a loss of time, is very liable to occasion the loss of many plants. When the plantation is large, it will be found convenient to establlsh several nursery beds, distributed in such a manner as to avoid these disadvantages. The surface of a nursery bed ought to be as level as the circumstances will allow, or at least to have a very slight inclination, so that the rains will not carry off the soil and so it will lend itself to irrigation.

The nature of the soil is of the greatest importance and must be carefully considered. It ought not to be any richer than the soil which later on is to receive the plants, because if it is, the coffee trees will suffer after transplanting through the diminution of nutritious elements; neither must the ground selected be notably poorer, because such a selection would also prejudice the tree, as the young plants would not acquire during their first stages, the development which is necessary to their future growth.

As a general rule, the planter ought to take a careful look over the whole of his ground, and select the spot which has the greatest similarity with the average land throughout his estate. Should he find it necessary to establish more than one nursery bed, it is clear that he will find it convenient to divide his whole land into plots of equal character, establishing a nursery bed for each plot. When the climate makes irrigation necessary, and this is found possible, it will be found advantageous to bear this in mind in selecting the ground for nursery beds, so that this operation can be carried on with ease and economy.

Preparation of the ground and arrangement of the nursery beds. Having selected a spot that combines the greatest number of the advantages above enumerated, the nursery bed is arranged in the most appropriate manner to facilitate the work of preparation, preservation and transplanting.

The ground is divided into beds with a width of 1.50 metres and a length of 15 to 20 metres, leaving walks between of one metre width and at a slightly lower level than the surface of the beds, which ought to be surrounded by drains. The plan on Fig. 6 shows the most convenient arrangement of a nursery bed.

With respect to the area which it ought to occupy, practical men are agreed that the number of plants in the nursery beds ought to be three times that required in the plantation, so that the planter will always have good trees to select for transplanting, with a reserve of trees for replacing those which fail.

The preparation of the ground is very simple and is reduced to a careful digging of the soil with a spade, so as to turn it up from at least 30 to 35 centimetres depth.

The ground is left in that condition for a month or more exposed to the atmospheric influence, thus giving it a perfect ventillation, and allowing it to absorb humidity. After that, it is harrowed over until it becomes perfectly level, when it is in a condition to receive the seed.

Selection of the seed. The success of the sowing in a great measure depends on the selection of the seed, the manner it is collected and the preparation that it undergoes before it is deposited in the soil.

The seed which is well adapted to germination, must be perfectly formed and have reached a proper degree of maturity, the latter quality being recognized by its having reached full development and by its falling naturally from the mother plant.

As the coffee tree bears fruit during several months, it is always easy to collect the seeds during that season and shortly before the time for sowing, care being taken in making this

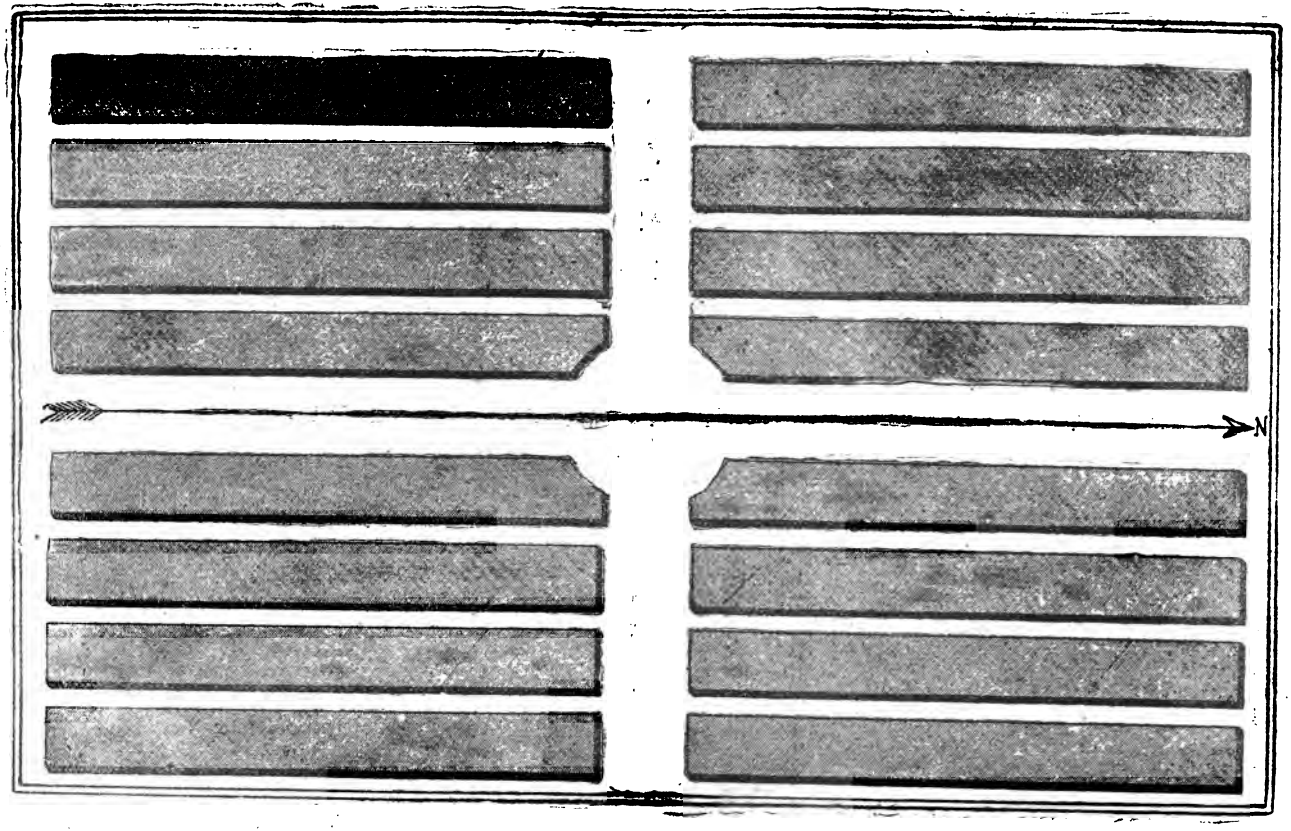


Fig. 6.

NURSERY BEDS.

collection to select the berries that have recently fallen from the trees, which appear strongest and best formed. The best formed coffee in that which is called in this country *Planchuela*, and this is the class that ought to be selected for sowing, as the *Caracolillo*, which is defective in its formation, is entirely unadapted for that object, notwithstanding the opinion of many planters who erroneously believe that it produces stronger and healthier trees.

Preparation of the seed. Amongst our agriculturists, the seed is generally sown in the same condition in which it is collected, but we would recommend its undergoing a very simple process of preparation, which has given the very best results in the greater part of the plantations in Guatemala. This process consists in taking the pulp off the berry, with the least possible illtreatment, after which it is slightly damped and exposed to the sun for a day.

Sowing. For this operation, parallel lines are drawn lengthwise along the seed beds, at a distance of 0.075 metres; and along these lines the seeds are placed at a distance of 7 centimetres from each other, the plane part of the coffee berry being placed downwards. Too much importance cannot be given to the question of the depth at which the seed is to be sown. Air and water are absolutely indispensable to the develop germination, and it is therefore very necessary to place the seeds at a depth that will allow of their receiving the benefits of these two elements. If the seeds are placed at too great a depth, they are deprived of air and do not germinate, whilst if they are placed too near the surface, they do not find the humidity which is also necessary. The depth at which the grains of coffee are placed varies according to the soil, but amongst practical planters they are generally sown at a depth of 4 to 8 milimetres.

At the same time, this cannot be taken as an invariable rule, as it must be varied according to the nature of the ground and the consistency of the soil. With very few exceptions, our plan-

ters sow the seeds, when in soils very full of clay, at a depth of 4 to 5 milimetres, and when it is of ordinary consistency, at 6 to 8 milimetres. Once the seeds are placed in the ground, they are covered with the earth from the sides of the furrow and then well smoothed over, either by hand or with a small roller. In some parts of the country, the planters prefer to cover the seed with a light layer of stable manure, which is scattered along the length of the furrow. Once the seed is covered, the whole surface of the bed is covered with a layer of damp straw or dry leaves, in order to diminish the evaporation and preserve a more even temperature.

Care after sowing. Having terminated the sowing operations, it is necessary to water the bed, which forms the chief part of the attention given thereafter. This watering must be continued daily for forty days, at the end of which time the seedlings begin to show up, when it will be necessary to take off the layer of straw or leaves which has been laid on, and then commence the construction of shade to shelter the beds.

This shade is commonly constructed by means of a trellis work made or sticks, supported by forked trunks which have a height of 1.40 metres, and which enclose the whole surface of the beds. The trellis is then covered with leaves of the banana or of any other kind that may be handy, leaving a few interstices to allow the light to penetrate. Care must be taken not to have too heavy a shade as the plants would then develop with too great an exhuberance, and would be covered with leaves of a dark green color, and on being transplanted would not take good root, but undergo a long season of delicate health.

Forty days after the plants have shown above ground, the beds ought to be gone over and every second plant taken out, preferring for destruction those plants which show least vigor.

This practice, which is very common in Guatemala, is omitted in some parts of this country, or, instead of throwing the plants away, they are transplanted to another bed where they are placed a distance of 0.20 metres from each other.

Season. In the coffee zone of this Republic, the sowing season is in the months of September, October and November, and the first transplanting is carried out in December, January and February.

The plants remain in the nursery for fourteen or fifteen months, during which time they must be attended with the greatest care. It is especially necessary to give the ground a careful weeding, as well as to pay great attention to watering. During the last months of their stay in the nursery bed, the shade on the plants ought to be gradually diminished until they are left entirely uncovered.

The plants will by this time have reached a height of 40 to 50[1] centimetres and are in condition to be transplanted to their permanent locations.

Before terminating this article, we must mention a practice which is recommended by Mr. E. Masferrer, an intelligent planter of Salvador, but which we consider unadvisable for the reasons which will be brought forward in treating of the question of pruning. This practice consists in pruning the trees in the nursery bed, for which purpose they are left there during 24 to 30 months.

SHADE.

Under certain circumstances, and when the temperature of the locality is rather more elevated than is convenient, or when the soil has a tendency to dry up and there are no facilities for irrigation during a prolonged drought, and in many other circumstances which cannot be laid down in an exact manner, it is in every way indispensable to provide shade for the coffee. Much has been said with respect to the advantages

1 Practical men call the plants which have reached this height by the name of "Four cross trees," referring to the number and distribution of the branches.

and disadvantages of shade, and even the best planters are not agreed on the subject; some alleging that it is absolutely indispensable, whilst others declare it to be injurious. Probably both are right; and in fact, the shade is sometimes entirely indispensable and at others, perfectly useless. In speaking on the subject of climate, we have already said that the coffee tree will support an elevated temperature, but only up to a certain limit, beyond which, an alteration takes place in its vegetative functions and the plant dies. There are many localities which through a number of circumstances are adapted to the cultivation of coffee, but which at the same time have the defect of an excessively high temperature. The planter can in such places diminish the effects of the solar rays on the plant and on the soil, and the best means for obtaining this desired object, is to provide shade. A great many cases could be cited showing the utility of the shade, but we do not consider it necessary to insist on the subject which is often determined in view of the local practice.

Whenever it is found necessary to provide shade, the following conditions ought to be borne in mind; firstly, the shade must not be total, but rather moderate; secondly, the tree which provides the shade, if the plantation is not in the forest, must a quick growing tree; thirdly, it must preserve its leaves throughout the winter; fourthly, it must not produce any heavy fruit or other substance that might damage the coffee tree; and fifthly, its roots must not grow laterally, but vertically.

These conditions must all be taken into consideration in sellecting the proper class of shade tree. In the coffee zone of this Republic, we have an abundance of trees of different species which fulfill the conditions above cited and of which we have seen some very successful examples.

The Huizache (acacia albicans) with its small leaves and elevated top, produces a moderate shade, but it stains the leaves of the coffee tree. The castor oil tree, which is so common throughout the coffee growing zone, could also be employed,

although not very advantageously, as it does not attain any great height. At the same time, we would call the attention of planters who are desirous of obtaining a profit out of this branch of their business, to the profits which they would probably derive out of the extraction of the oil. Many other trees are used in different parts of the country whose names are not here given as they are entirely unknown outside of this Republic. The greater part of the woody trees that could be advantageously employed to furnish shade for the coffee tree, have the disadvantage of a very slow growth and therefore can only be utilized after a long delay, and the result is, that most planters find themselves obliged to have recourse to the banana.

This tree, which has such a rapid development, has nevertheless several great disadvantages, and its use can only be justified by necessity. It is true that its fruit, which is so much sought after for exportation on account of its great popularity, can be of material assistance in covering the expenses of the plantation, but nevertheless it ought to be only utilized as a temporary expedient and whilst the woody trees acquire the development necessary to furnish the desired shade; and it cannot be denied that during this period the banana tree is of the greatest service to the planter.

The banana tree is one of the largest of the herbaceous species; it really has no trunk and the upright stalk which lookes like one, is formed of the embryo leaves which are folded one over the other, thus forming a conical mass reaching a height of 2½ to 5 metres, with a circumference of 50 to 80 centimetres at its base. Its upper part is formed of a crown of large leaves, which have a length of 2 metres and a maximum width of 30 to 40 centimetres.

These large leaves produce a shade that does not fulfill the primary condition, as it cannot be moderate; whilst on the other hand, they often injure the coffee trees in falling, and during the rainy season, they form spouts along the centres of the

leaves, allowing the water to fall in torrents on particular spots. This tree propagates itself by suckers, of which four or five are found round each trunk, and must be destroyed as otherwise they would very soon overrun the space reserved for the coffee trees.

These suckers, which can be purchased at a very low price, are those which are planted in the manner indicated in another chapter and at distances which vary according to the degree of shade which the planter desires to obtain. A line of banana trees is often interposed between every two or three rows of coffee trees, and they are placed at a distance of 2½ to 3 times the space between the latter. The suckers are planted during the dry season and with all the care that is required for ordinary transplanting, because although the banana tree rarely dies in that operation, it very often happens that it is injured by careless transplanting, and does not furnish the desired shade in due time.

This plant has a very rapid growth and only delays a year at most, in throwing out a fruit stem which carries forty to sixty and even more bananas. This stem, which commonly weighs with its fruit from ten to twelve kilograms, ought to be cut a short time before maturity, as without this precaution, it is a probable danger to the coffee trees.

In those localities which are exposed to strong winds, the banana is also dangerous through the weak resistance it presents. The construction of its tissues, which are very watery, weakens its forces, and the folds which form the trunk, present numerous and large cavities which are found in regular order.

This country produces many varieties which can be employed for shade, such as the Long Plantain (Musa Baradisiaca). The Guinea Plantain (M. Sapuentum); the Abyssinian Plantain (M. Ensete, Bruce); the Dominican Plantain (M. Regias Kumph); the Chinese Plantain (M. Coccinea), and the Manilla Plantain, all of which develop with equal facility, and ought to be selected according to the richness of their fruit.

Against the disadvantages of the banana as a shade tree, it presents an important consideration, which is not found in any of the woody species, and consists of the restitution of organic matter. The banana tree furnishes a very large quantity of organic refuse, which is very useful in the state of decomposition. After the fruit has been gathered, the principal trunk is cut down aud furnishes twenty to thirty kilograms of matter without counting the great number of leaves which have preceded its fall. In many parts of the State of Michoacan and especially in Uruapan, the remains of the banana tree are utilized by burrying at the foot of the coffee tree, and it appears that good results are thus obtained although this is not the best method for that purpose. A better method is to collect this refuse and throw it into a ditch dug for that purpose, after which it is watered and moved from time to time in order to facilitate the process of decomposition. It thus undergoes fermentation with all its consequent transformations, until at last a manure is obtained which is rich in azote, potash, lime and phosphoric acid, all of which are extremely useful to the coffee tree. The amount of water contained in the tissues of the trunk, is always considerable and reaches as high as 94 per cent. The stalks of the leaves form a very dense tissue which contains from 20 to 25 per cent of dry matter.

A proportional mixture of stalks and leaves has given the following results:

Water	90,800
Dry matter	9,200
	100,000

Mineral composition.

	Composition of the ash.	Proportion of ash per 1000 kilograms of fresh matter.	Proportion of ash per 1000 kilograms of dry matter.
Phosphoric acid	1.26	0,130	1,406
Sulphuric	1.22	0,126	1,361
Chlorine	8.50	0,875	9,486
Carried forward	10.98	1,131	12,253

	Composition of the ash.	Proportion of ash per 1000 kilograms of fresh matter.	Proportion of ash per 1000 kilograms of dry matter.
Brought forward.....	10.98	1,131	12,253
Lime	17.28	1,780	19,285
Magnesia	2.64	0,272	2,946
Potash.....	28.86	2,972	32,208
Soda.....	9.54	0,983	10,647
Oxide of iron.....	0.74	0,076	0,826
Silica	15.39	1,585	17,175
Carbonic acid, etc.....	14.57	1,501	16,260
Total mineral matter.....	100.00	10,300	111,600
Azote.....		1,090	10,900

These figures should be borne in mind, in treating of the subject of manure.

The use of the banana, we repeat, is necessary when forest trees have not been reserved; but even in this case, it should only be used as a temporary expedient, and at the same time that the banana is planted, or even before if possible, trees of a woody class should be planted with it, so as to take the place of the former when it can be done with advantage.

It is necessary to call the attention of planters to the degree of shade which is to be given to their plantations, because when too much shade is provided and the humidity thereby increased, the length of the coffee stalk is greatly developed, its leaves take on a dark shade, and though they give a handsome appearance, the amount of fruit is greatly diminished. We have remarked a tendency to excessive shade over the coffee tree, as the planter thinks that he thereby avoids the expense of weeding; and though it is true that he does economise in this matter, the saving is out of all proportion to the loss in fruit.

TRANSPLANTING.

The rainy season exactly defines the most advantageous time in which to begin the operation of transplanting.

After the first rains have thoroughly soaked the soil without

ofloding the holes and turning the earth into mud; the planter waits for a cloudy or slightly rainy day in order to proceed with his transplanting. This is a simple, but at the same time delicate operation, which ought to be very carefully carried out, as otherwise, there is great risk of losing the young plants, and consequently the expense which they have caused during their stay in the nursery, besides the expense of transplanting. The state of the weather has also an influence on the result, and for that reason it is preferable to work on the damp days as above stated, suspending operations during the days of heavy rain or of bright sunshine. The days of heavy rain have the disadvantage of rendering the work difficult on account of the unfavorable conditions under which the laborer works, as he cannot act with freedom and rapidity, whilst the soil from which the plant is taken is in a bad condition, and the transplanting is almost certain to be carried out in a slovenly manner. In those soils which consist of a strong clay, the transplanting operations are impossible during a heavy rain, whilst dry weather is entirely unsuited to the work.

This operation includes several distinct parts which we propose to treat separately: the extraction of the plants from the nursery beds, their transportation to the permanent plantation and their placing within the holes.

Extraction of the plants.—The coffee tree ought to be transplanted in company with all the earth that covers its roots. In order to carry out this operation with ease and rapidity, the laborer is furnished with a narrow spade, the width of which is proportioned to the average size of the clod which is to accompany the plant. He digs a sort of ditch round the plant with a width of about 5 centimetres and with a depth in proportion to the size of the plant, in all cases avoiding any injury to the small roots.

Before extracting the tree with its accompanying clod of earth, the laborer, who must be previously informed, cuts the end of one of the small branches on the eastern side, so as to

be able to set the plant in the same relative position when transplanted to the plantation. This may appear an excess of precaution, but in giving the reader this hint, we have borne in mind the observations of the most intelligent and well informed planters. On the other and, when we come to examine this rule, we do not find that it disagrees with the scientific principles of agriculture. The plant is then extracted by taking the clod of earth between the hands and is carefully placed in the basket or box in which it is to be transported.

Transportation of the plants.—These are commonly transported in large sized baskets, the trees being placed with the roots downwards and leaning against the sides of the basket. This practice is not the most favorable, as the plants necessarily suffer some illtreatment and thereby run a risk of permanent injury. A better plan is to make use of special boxes constructed for the purpose. The principal part of this box consists of a rectangular figure made of wood, at the bottom of which is stretched a thin coarse tissue and which is secured to the sides of the box. It is also provided with four handles, so placed that it can be carried by two men. The bottom is then lined with a damp cloth on which the plants are arranged in a horizontal position and with the roots turned towards the sides of the box, so that the trunks from each side of the box cross in the middle. These boxes ought never to be packed so as to crowd the plants. After being arranged in the box, the trees are covered with a damp cloth and carried to the proposed plantation.

This manner of transporting the plants will appear expensive, but it will not be found so when the planter has expert laborers and a sufficient supply of boxes, besides which, this method almost guarantees a successful transplanting.

Setting the plant.—For this operation it is best to select the most intelligent and expert laborers to be found on the plantation. They must be provided with a small shovel and a knife, and taught to proceed in this manner: the laborer takes

one of the plants and carries it to the hole in which it is to be set; once there, he cuts the tap root in a diagonal direction and sets the plant in the hole in such a manner, that the branch which was cut to show the East should remain pointed in that direction. The plant must remain in a perfectly vertical position without bending the tap root, as otherwise the plant is certain to die, if not inmediately, within a year after transplanting. When the root of any vegetable is bent over it forms a knot which prevents that organ from fulfilling its normal functions.

The operation of setting the plant must he executed with great care; the clod round the roots must be carefully placed in the centre of the hole, so that it may receive on all sides, the earth which is to support it. Care must also be taken to place the first earth extracted from the hole, and which formed the original surface of the ground, at the bottom, after which, the earth that came out of the intermediate layer will be thrown in and lastly, that which came from the bottom of the hole, this being slightly pressed with the hand, so as to leave the tree firmly planted.

Once the tree has been firmly set, the roots are covered with a little surface soil which is heaped up to an elevation of 6 to 8 centimetres and firmly pressed down in order to avoid the collection of water.

With this operation, the transplanting is concluded.

In many plantations in the Southern part of this country, we have seen two coffee trees set into one hole. This practice appears very advisable when it is carried out in soils of moderate fertility, and where the plant can attain a moderate, but not exagerated development. There is no doubt that better results are obtained under this system, as without increasieg the expenses of cultivation over a given area, the production is increased by at least 60 per cent over that which would be obtained by setting the plants out alone. It is very probable (and from my own observation I consider it certain),

that the increased returns from the coffee plantations of Oaxaca are due to this circumstance, as the planters of that State consider a twin plant as one.

On tbe other hand, this method is not peculiar to Mexico or even to the State of Oaxaca, but for many years has been practised in the coffee plantations of Brazil.

In very rich soils this method would produce bad results. The trees there acquire a very exhuberant development and the branches mutually disturb each other, preventing the pentration of light and the circulation of air, and hindering the formation of the fruit.

PRESERVATION.

Weeding.—In all hot climates, the ground becomes covered with an infinite number of herbs which invade the entire surface and absorb the nutritive elements to the perjudice of the cultivated crop. The object of weeding is to destroy these obnoxious plants and keep the surface of the soil exposed to the action of the atmosphere. The weeding of coffee plantations is very frequently neglected in this country and it is pitiful to see the wild condition of many plantations in many parts of the Republic. A careful planter will never neglect this important operation.

The operation of weeding is absolutely indispensable, and as we feel certain that any moderately well informed person will be of the same opinion, we do not enter into the useless task of demonstrating its truth.

The operation of weeding can be carried out by the use of different instruments. the principal of which are: hoes, culvators and implements for cutting brush. The last mentioned tools are those which do the most damage and we believe ought to be left out whenever possible.

The work done with these brush cutters is always imper-

fect and untidy. It is imperfect because the cutting is done at some distance above the surface, so that the root of the noxious plant remains intact and immediately sprouts at some other part, whilst on the other hand, there is a great probability that if the tool is handled by some careless person, he will injure the trunks or branches of the coffee trees. Comparing the work of this kind of tool with that of some other implement, such for example as the hoe, it has been found that the latter system of working is undoubtedly dearer than the other.

The weeding with a hoe has the defect of being slow, but on the other hand, it has the advantage of being more useful, as the destruction of the weeds is very complete. The cost of this work as compared with that which is done with brush cutters, is a little lower, but it is not the most economical. There is no doubt that cultivators are the implements which will execute this work with the greatest rapidity and with a certain amount of perfection, as they result in a considerable economy of time, money and labor, besides giving the soil a good turning over.

Several models of this implement are found in the market, specially manufactured for the cultivation of coffee, but we do not feel at liberty to recomemmend any particular one, and only lay down the general conditions which ought to be found in an implement of this character, as shown in the work written by Mr. Rafael Barba: "1st. The implement ought to be solid in construction with a light weight; 2nd. The teeth ought to he easily changeable according to the class of the work, and their form ought to be such as to present no great difficulties in the way of the work; 3rd. The bars on which the teeth are fixed ought to permit them to be changed without difficulty; 4th. The form of these bars and their arrangement ought to be such that the implement could not easily be choked with weeds; 5th. It is indispensable that it should be adapted for throwing the teeth into the earth or out of it, either to clean them when

required or to remove the implement to another part, whenever it is not working."

This implement can be managed by one man and drawn by a single steer led by a boy.

The only precaution that is required, is to see that once the teeth have been arranged for depth and width of work, the point which comes closest to the trees shall not burry itself at the foot of the trunks, and that can be easily managed by giving the cultivator a slight inclination by means of the handles.

This implement cannot however come into general use, as it would only give the best results on a perfect level plantation, with very few stones or trunks, and especially requires that the trees should be planted in perfect alignment, without which conditions, it is impossible to use it. In spite of the attempts made by many planters, the employment of ploughing implements has not produced the best results.

Whatever may be the implement used, the weeding must be done along the paths between the trees and in a direction at right angles to the general slope of the ground, the object of this being to prevent the loose soil from being carried away by the rainwater. With respect to the number of weedings that are required and the season of the year for doing the work, no fixed number can be laid down which would apply to all cases, and we can only give the general rule that the weeds ought not to be allowed to grow over fifteen or twenty centimetres. As the growth of the weeds greatly depends upon the fertility of the soil, the annual number of weedings which are given within the coffee zone of Mexico, vary from three up to ten and twelve per annum.

Irrigation.—In many parts of the Republic, and for example, in almost the entire State of Veracruz, the coffee tree is cultivated without irrigation, but in other parts where the planter can count on a supply of this precious element, it is very advantageously utilized during the dry season. In those plantations where the owner is able to irrigate from a stream, the

trees are better preserved, their production is more regular and they repay the care of the planter with earlier and more abundant crops.

In the article in which we treated of climate, we have shown how necessary humidity is to the coffee tree, and especially if it is situated in a district with more than a moderate degree of heat. The reader will understand from this the importance and usefulness of taking advantage of his irrigating facilities whenever a prolonged drought takes place.

As soon as the damp weather has ceased, the ground begins to show the effect of the dry weather and the plant to shrink. The ground itself shows the necessity of irrigation, which ought to be given with moderation, both with the object of preserving sufficient heat in the soil as well as to prevent the tree from acquiring too great a length. It is necessary to take care not to irrigate immediately after taking off the crop, as it is necessary to allow the plant repose for a certain time, which varies from one to two months. The land must be irrigated as often as it appears to require it and without adhering to any determined rotation, which generally is not founded on scientific facts.

We often hear of planters who have designated an interval of one or two weeks for opening their ditches, but the better plan is to vary the number and degree of the irrigations in accordance with the variations in the degrees of dryness. Before the flowering season, it is not desirable to irrigate heavily, as the object is only to stimulate the plant. It will, therefore, be found prudent to give moderate irrigation at the approach of the flowering season.

A few days before the planter begins to see the buds on the trees and during the time that these buds take to develop, the irrigation ought to be entirely stopped, as otherwise the life of the buds will be suspended and eventually be lost. Once the fruit has developed, the irrigation can be allowed with more frequency, but it must never be excessive.

It sometimes happens that the coffee tree will blossom three, four and even six times; the planter will then take particular care to arrange his irrigation in such a manner that he will not interrupt any of these flowering seasons.

The irrigation is carried out by various methods, but the especial object of each is to inundate the foot of the tree. In some parts the irrigation is carried out as shown in Fig. 7, this

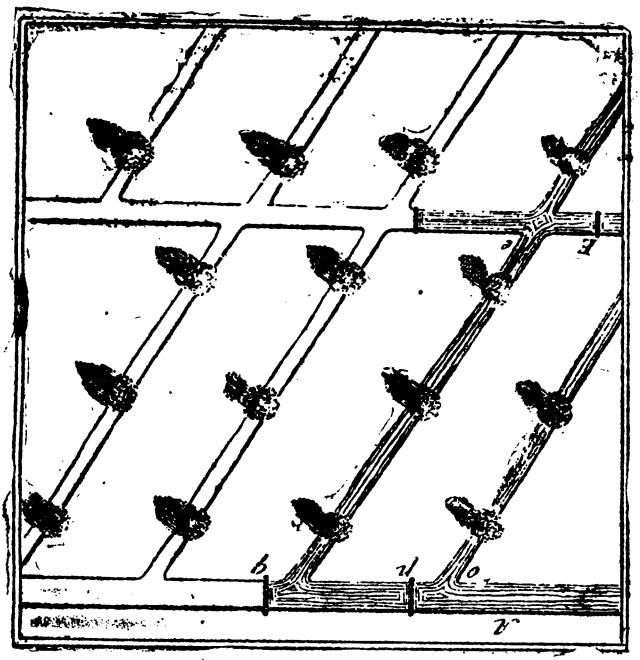


Fig. 7.

method being applicable to level ground. *A* is the irrigation ditch from which is run a branch *o*, which follows the line of the trees until it reaches the end of the plantation or of the block that is to be irrigated by this ditch; in this case, it is continued as in *e* until it meets the next irrigating ditch and so on over the whole block. The irrigation ditch is formed by raising small dykes along the lines of trees. The laborer in charge of

the operation dams up the water with clods of earth or better still, with a small board cut for the purpose. He puts in his dam at the point p, thus turning the water off along the smaller ditch until it reaches e, where it is prevented from going further by another little dam.

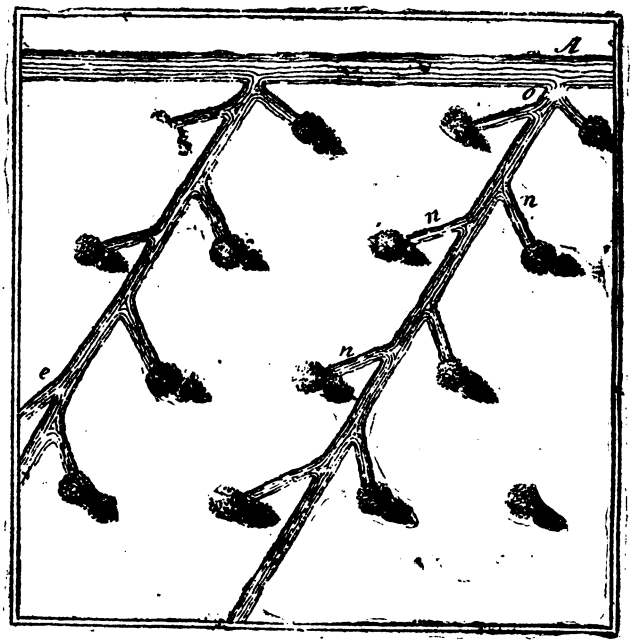


Fig. 8.

When the ground along the first subsidiary ditch has been sufficiently watered, the dam at e is taken up, so that the water passes to the next ditch, and this operation is repeated until the whole block has been sufficiently irrigated.

When the length of the subsidiary ditches is so great that the amount of water reaching E is very much reduced, the dam at p is taken up and passed on to q, and so on successively.

This system of irrigation, although cheaper than others, cannot always be preferred, both because the ground does not al-

ways allow it, as well as for the enormous amount of water which is required.

Another arrangement is that shown in Fig. 8. Irrigating ditches *o* and *e* are connected with the main ditch *A*, the former running parallel to the lines of the coffee tree, and from these are carried out small branches *n* which conduct the water to holes formed at the foot of each tree. When the ground has a considerable slope, the hole is formed on the upper side of the tree and the earth thrown out on the lower side.

It is impossible to fix exactly the amount of water required for any given area, as that depends entirely upon the degree of dryness in the soil, its permeability, etc.

PRUNING.

Amongst the most interesting operations in arboriculture, pruning holds the first place, and when applied to the coffee tree with intelligence and good judgment, it increases and regulates production.

Du Breuil says in his interesting work, that trees which have not undergone pruning, often give an abundance of fruit, but this abundance is very intermittent, and if the crop is good one year, it is most probably short the next. It is well known that this irregularity proceeds from the fact that during the year of abundance, almost all the sap has been employed in the development of the fruit, and through that very fact, there has not been enough left to prepare flower buds for the following year. A well considered and prudent pruning, results in lhe disappearance of these irregularities, as the economy of sap which follows the cutting of the sprouts, allows the tree to dedicate its strength to developing its fruit and to the preparation of new branches for the following season.

Theoretically speaking, the pruning cannot be more rational, and when applied with judgment in practice, the results

are entirely satisfactory. The beauty and remarkable production of trees and shrubs which have been carefully educated in gardens and orchards, and which, from their earliest age have been trained to a regularity or form by means of a carefully studied pruning, demonstrates how far man can reach when he knows how to apply the scientific principles of arboriculture.

The scientific principles of pruning are undoubtedly applicable to all plants, but in a distinct manner for each class, according to lhe physiological conditions of its development.

In pruning the following objects must be carefully borne in mind:

1.st *To suppress all the useless parts of the plant.*

2.nd *To adapt the form of the plant to the necessities of the crop, procuring a good development in length, breadth and symmetry.*

3.rd *To procure the largest and most constant production.*

1.st The suppression of the useless parts of the plant does not form the most important object of prüning, but it ought always to be done, destroying the shoots that start from the foot of the trunk as well as all the branches which do not blossom, as all these parts of the plant consume the sap without giving any return and with prejudice to the organs of fructification. The shoots at the foot of the trunk can be destroyed by hand, whilst they are still green. The non-flowering branches ought to be cut off close to the main trunk, and the same ought to be done with all dry or sick branches.

After the second crop has been taken off, and often after the first crop, the branches which are close to the ground do not flower and often throw off their leaves; these branches ought to be cut off as soon as noticed, care being taken not to injure the trunk. Many persons are of opinion that one or two knots ought to be left on these branches in order that they should throw out fresh shoots and replace the whole branch; this, which appears very reasonable, is an inconvenient practice, because the fruit of these branches is always scarce, and we

believe that it is preferable to occupy the sap which they consume in the nutrition of other branches that are undoubtedly more fruitful. The lower branches are always badly situated for the reception of light and heat.

2.nd The reader will easily understand the necessity of training the form of the coffee tree, so as to give it good conditions of length, breadth and symmetry.

The tree which is abandoned to its natural development, stretches out indefinitely, both in length and breadth, both qualities being very inconvenient; the first because it hinders the collection of the crop, and the second, because with wide spreading trees, the branches of one interlace with those of its neighbors, thus preventing the penetration of light and heat, as well as the circulalion of air. Symmetry is indispensable to facilitate the vegetative functions, as it secures the equilibrium of the tree and the easy circulatión of sap within its branches.

This part of the pruning, which properly ought to be called *morphological*, is of the greatest importance, and its rules of practice are based on scientific principles, the knowledge of which is indispensable, and for that reason we now proceed to describe the natural development of the coffee tree.

Natural vegetation of the coffee tree.—Thirty or forty days after the seed has been placed in the ground, the plant appears and gradually develops until it is complete, consisting of a trunk and two opposite terminal leaves.

The after development is carried on by a terminal shoot which prolongs the trunk in a vertical direction and by two latteral opposite shoots, which shortly after sprout at the base of the primitive leaves, which then fall. At this period the small coffee tree has a main trunk provided with two terminal leaves and two side branches which are equally provided with leaves.

At the upper extremity of the trunk, a terminal shoot develops prolonging the trunk, and later on, two other shoots forming branches, are developed at the base of those leaves and

in a direction at right angles to the first branches. The vertical plane of these branches forms a right angle with the vertical plane which passes through the centre of the terminal leaves of the main trunk. These are the planes of natural vegetation of the coffee tree.

A similar thing takes place on the lateral branches of the first formation; the terminal shoot develops prolonging the branch, and the two lateral foliaceous branches give birth to leaves.

The development of the plant continues in the same manner; in the trunk by means of the terminal shoot and in the branches by the same means. The arrangement of the leaves on the secondary branches is the same as that which these branches have with respect to main trunk, that is to say, on planes at right angles, and although they are apparently arranged at right angles to the trunk, yet if they are observed with attention, it will be seen that this is not certain, but that they preserve the position indicated and that it is the limb which is turned with the object of better fullfiling its physiological functions.

When the branches have acquired a considerable development, they commence to change their direcction and slightly bend downwards.

The vegetation continues in this manner during the first three years which precede the first blossoming of the coffee tree; when this season arrives, the tree has attained a height of one or more metres and is naturally symmetrical in form and well covered with leaves. At this period, the tree has a handsome form, and if well observed, no strong and thrifty tree will be found disproportioned in shape.

The flower buds then begin to appear at the base of the leaves on the primary branches which start directly from the trunk, and in groups composed of two or four buds on each side, except during the first year, when they are generally two. They will only be found on that part of the branch which has

been formed the previous year, as the end which has developed in any year, can produce no flowers until the next.

After the first blossoming of the coffee tree is over, the secondary branches appear starting from the first knots of the primary branches, and their development goes on in the same manner as that of the parent branch.

The evolution of the flowers is well worth attention, it affords us the explanation required for the rules with respect to the collection of the crop.

At the point of insertion of the leaves, a shoot appears that produces only one peduncle, which shortly after bifurcates, producing two buds. During the first year, the blossoming does not go any further, but during the following years, and even during the first when the plant is very strong, the peduncle which starts from the foot of the leaf, after bifurcating once, continues growing and repeats the operation, producing two other flower buds. As the development of these latter buds comes after those of the first bifurcation, and as on the other hand, the growth of the flower buds is centrifigal and is from the centre towards the periphery, and successively knot by knot, we can understand the reason of the different blossomings of the coffee tree, and consequently of the different crops.

In the coffee zone of the Republic, the coffee tree bears flowers two, four and even six times in the year.

From what we have above written, we reach the following results:

I. That the terminal shoots being of a foliaceous character, the growth of the coffee tree is indefinite.

II. That the coffee tree naturally assumes a symmetrical form, at least before the development of the secondary branches.

III. That the evolution of blossoms assumes a centrifugal form, proceeding from the trunk towards the extremities of the branches.

IV. That all the branches bear fruit, with the exception of those which have an abnormal character, and

V. That the knots of the primary branches continue bearing fruit until they begin to throw out secondary branches.

The first conclusion shows the necessity of limiting the development of the tree, and with that object the planter cuts the shooots and budding branches.

When the coffee tree has reached a height of two metres, measures are taken to prevent its further growth. As we have already stated, the upper part of the tree terminates in a shoot which prolongs the trunk and whose development gives birth to two branches. It is now necessary to wait till these lateral branches have appeared, and when they are about 6 or 8 centimetres in length, the last cross is cut a little below the last knot. This operation must be done with a sharp knife and the cut made diagonally upwards so as to injure the tree as little as possible.

Should the highest lateral branches have acquired any great development, it would be prudent to cut their renewals with the same precautions. The object of this last operation is to prevent the weight of these branches bending the trunk over and causing the loss of a large part of the tree. When this unfortunately happens, it is necessary to cut the trunk inmediately about five centimetres below the bend, making the cut with a sharp intrument and giving the nearest lateral branch a vertical direction so that it shall take the place of the trunk. In order to limit the lateral development of the tree, it is necessary to cut the end shoots of the branches.

The pruning of the branches is done by breaking the terminal shoots off by hand as soon as they appear, and this operation can be done by the laborers when they are collecting the last of the crop. The result of this operation is that the lateral shoots unfold themselves and bifurcate the primary branches towards their extremities, and that the sap is attracted towards this part of the tree with increased energy, to the de-

triment of the other parts of the branches. The fruit thus becomes more abundant towards the middle of the branch leaving the knot nearest to the trunk bare of fruit. In order to avoid this, it is well to prune the lateral shoots at an early stage, so that the branch shall only have the indispensable number of knots. The following year, the lateral pruning can be carried out in the same manner as the terminal pruning.

The planter has no need to take any special care with respect to the symmetry of the tree, as this comes in a natural manner, especially during the first six years of its growth, so that any special affort directed to this object will be entirely useless.

3. To obtain the largest and most constant production, is certainly the most important object of pruning, and at the same time, the most difficult to attain. This part of the pruning, that may be properly called stimulating, is carried out with the object of leaving the fruit bearing branches conveniently arranged, that is to say, procuring that their number shall be that which the tree can properly nourish. Amongst our planters, this system of pruning is entirely unknown, although it appears to have been employed in some of the estates near Córdoba, but with rather unsatisfactory results.[1]

In order to obtain good results, it is necessary to have a perfect knowledge of the natural vegetation and conditions under which the coffee tree flowers, and without this knowledge the results will probably be nugatory. Many persons have formed empirical rules that cannot be applied with any certainty in all cases, and they very often lay down the periods in which these rules are to be complied with, but not one has as yet given details showing the rational manner of practicing pruning. No absolute rules can be laid down for the practice of tech-

1 Mr. H. Finck has been the first to undertake a pruning in proper form, and the results which have been obtained can not be considered satisfactory; but nevertheless, we cannot from this assume that this operation is injurious, in view of the good results obtained with other plants.

nical pruning, as each individual is a law to himself, according to his special conditions; and this forms the principal difficulty.

There is no reason for the application of a stimulating pruning before the secondary branches reach a complete development, as at this period the number of branches is relatively small, and if we bear in mind that they all bear fruit, it will be easily understood that the suppression of any of them will lessen the crop. When the secondary branches have assumed a considerable development, and the number of tertiary branches become so numerous that they intermingle and prevent the penetration of sunshine, the full pruning becomes necessary, as by that time the trees have the strength to bear fruit on all the branches. The operations of pruning are very minute, aud although they can be perfectly applied to a small number of plants, they become impracticable in plantations of a hundred to two hundred thousand trees. Besides this, although the operation appears simple, it really presents some difficulties, and we believe that the planters ought to receive the many rules which are laid down on this subject, with a good deal of caution.

After the lateral budding is concluded, the secondary branches become more vigorous and form numerous knots; but their growth must be restrained so as to not allow them to mix with the twigs from the other branches.

The number of knots that ought to be allowed to remain on the secondary branches ought to be equal to half the number of knots contained in the primary branch.

The secondary branches which arise from the first knot on the primary branch, that is to say, from that which is nearest to the trunk, ought only to be allowed to bear fruit on one occasion, and then to be destroyed.

The number of secondary branches ought always to be even. No tertiary branches ought to be allowed to appear before the secondary branches which have sprouted from the ends of

the primary branches, have borne fruit. After the secondary branches have borne fruit two or three times, they must be substituted for tertiary branches. No branch ought to be allowed to bear fruit more than three times.

All pruning operations must be carried out with the instruments ordinarily employed by the pruner, using a saw for the trunks and strong branches, a knife for the bark and smaller branches, and shears for the soft parts. The pruning ought to be done with a perfectly clean cut, as the coffee tree suffers greatly from any wounds that may be left by the instruments, for which reason a close pruning is very dangerous.

In order to avoid accidents, the following mastic can be employed, applying it to the wounds of the plant with a wooden spatula:

Lhomme–Lefort mastic.

Yellow beeswax	65	grammes.
Trementine	65	,,
White resin	32	,,
Sheeps' tallow	16	,,
Total	178	grammes.

This mixture is melted together and kept in a closed vessel.

This mastic hardens in very few days and does not soften with the heat of the sun, whilst the humidity facilitates its solidification.

To resume, the pruning operations ought to be executed in the following order:

In the seed bed. No pruning can be done as long as the tree is in the nursery. The coffee tree which may be found diseased, whatever may be the cause, must be totally destroyed.

After transplanting. As a general rule which is aplicable to all seasons, it will be necessary to suppress the renewals, the withered branches and those which may be diseased or of an abnormal character. This operation ought to be done, and can be done, in any season.

After the first crop has been taken and when the coffee tree has reached a height of two metres, the terminal pruning which we have already referred to, can be done. This operation will be carried out after the disappearance of the blossom, so as to encourage a lateral development. A good crop can be obtained by cutting off the point of the coffee tree when the flower buds begin to show, but if the planter obtains this crop, he will find that of the following year very much reduced.

When the lower primary branches reach a length of 55 to 65 centimetres with eight to ten knots, it is necessary to commence the lateral pruning. This operation can be done immediately afer taking the crop following the cutting of the top, but in very advanced plantations where the plants are strong and healthy, it is necessary to await the appearance of the flower buds, as otherwise, it might encourage the formation of all the secondary branches.

When the lateral pruning is done in due season, the primary branches bear a good crop and form secondary branches in the terminal knot.

In giving the lateral pruning, in is necessary to cut the primary branches which have fully developed on the upper part of the tree. The lateral pruning encourages the growth of the secondary branches.

Six months after the ends of the branches have been pruned, the secondary branches which have grown on the ends of the primary branches ought to be cut, as without this precaution the planter runs the risk of rendering the primary knots near the trunk sterile.

When the secondary branches have sufficiently grown, their tips are cut off so as not to allow the growth of the tertiary branches. The subsequent operations have for object the substitution of the secondary branches, this constituting the most difficult part of a technical pruning. The substitution of the secondary branches is done by cutting them off a little below the second knot which has produced tertiary branches. The

stronger of the two tertiary branches appearing on the last cross is then preserved and given the direction of the secondary branch.

The pruning of the trees must be limited by cutting off the points of the secondary branches, as any further operations are rendered impractical by their expense; it will be necessary to make from 280 to 400 cuts in each plant, and as the pruning operations can only be confided to intelligent laborers, whose number unfortunately is very reduced, it becomes impossible to apply these rules and still more so, to apply them in season.

RENEWALS.

However much care may be bestowed on the plantation, it is impossible to prevent some of the plants already set out, from becoming diseased or from withering.

The careful planter will every year observe these defects and replace the plants which may be lost. In speaking of the nursery beds, we have already said that they ought to contain three times the number of plants that are required in the plantation, and this chapter will explain the reason for such a provision. A year after the setting out of the plantation, that is to say, during the following rainy season, it will be necessary to replace in the plantation, all the trees that for any reason may have died. This operation has to be carried out with even more care than the original setting out, and the holes in which the trees are to be set out ought to be left open as long as posible before and be given a good width.

It will be found prudent to take a careful look over the ground, and if possible manure it in the manner shown in our chapter on the subject, as these losses often result from some defect in the soil. The hole ought to be opened out as soon as the loss of a tree is noted.

The renewal ought to be made with all the care that we have previously indicated for the original setting out, taking advantage of the first rains, as otherwise, it is preferable to wait until the following year and not run the risk of a fresh loss.

The tree which is intended to supply the place of the lost one, ought to be more vigorous than those which serve for the original formation of a plantation, as otherwise, it would suffer more from drought, and not having time allowed it to adapt its functions before the disappearance of the rains, it would undoubtedly be lost.

During the second year the same precautions must be taken to carry out the renewals, and care must be taken to have the nursery beds well provided with young trees for this purpose. We strongly recommend the planter, at once to destroy any young trees which may be found diseased, and not to attempt to improve them by pruning or excessive manuring, as besides being very expensive, this method will be found poor in results. The diseased trees must always be replaced, as there is no other way to remedy the evil.

This refers to isolated plants, and not to those cases in which a disease has attacked any notable area of the plantation.

The Arabs appear to have some strange notions with respect to renewals, a practice which they altogether omit. Lepelletier says: "I cannot give any exact idea of the mortality after the trees have attained their full growth, as this depends on the degree of dryness and on the worms which eat the roots; but I have been assured that in years of drought, many trees die, whilst in those which have abundant rains, very few die.

The planters in the neighborhood of Saana, Hoaden, Habech, Djebelskas and Charab, never replace the full grown coffee plants which may have died, as they are persuaded that the new ones which might be set out in their place would wither from the same causes, hence the many vacancies which Bréon has observed, and which are greater in proportion to the antiquity of the plantation."

The renewals are necessary, as otherwise, the vacancies accumulating from one year to another, would occasion a considerable loss, not only by the diminution of the crop, but also by the fruitless increase of expenses.

The shade trees which may be lost, ought also to be replaced with as much attention and care as the coffee trees, as the vacant spaces amongst them may cause heavy loss through the exposure of the coffee trees to sun.

GATHERING OF THE CROP.

Three or four days after the flowers appear, they begin to fall off, leaving in their places the embryo berries which will be collected eight or nine months further on. We have already said that the flowers do not appear simultaneously but successively, and the result is that the fruits do not ripen at the same time. For this reason, the picking season lasts as long as the flowering season.

The duration of the flowering season, as we have already said, varies in different parts of the country, but in Mexico it is generally included within the months of January, February, March and April. The crop is collected during the months of October to January.

When ripe, the fruit forms a scarlet berry, consisting of a slightly sweetened pulp, enclosing two grains, plane on one side and convex on the other and which are enclosed in a parchment like pelicula which holds the two grains apart from each other and from the pulp. These grains, when dried and deprived of the parchment cover in which they were held, form the coffee of comerce. The grains are formed of a tissue with a horny appearance, of a slinghtly greenish lead color, which at times takes on a yellow, blackish or whitish tinge.

The convex side is perfectly smooth and continuous, but the plane side, which has a more or less regular elliptical form, has

a furrow along its whole length which is continued internally and forms a small cavity. The parchment skin that encloses the grains, penetrates into the interior of the cavity, through this furrow. The solid part is formed of a cellular tissue, which is very watery and is easily dried, and is surrounded with a shiny skin of a reddish color when the fruit is ripe and fresh, but which when dried, assumes an opaque appearance, a dark brown color and becomes very brittle.

In its normal condition, the berry encloses two grains, but it sometimes happens that one of them acquires an excessive development, producing the fruit that is called caracolillo on account of its similarity to the shell of certain species of *gasteropide.* This product, whose price is much higher in the market, has given rise to a great deal of discussion on the part of cultivators, with respect to its origin. The formation of the caracolillo is easy to understand; it undoubtedly arises from a bad fertilization or defects in nutrition.

In the first case, which is probably the commonest according to the opinion of Mr. J. C. Segura, the fertilization only took place in one estigma and the berry only developed with respect to the lobe which is so fertilized, leaving the other sterile.

This defects in fertilization may have been determined by the injuries which insects may have inflicted on the organs of the blossom, or by an organic defect in the blossom itself. In the second case, which has also been observed, the fertilization takes place in both lobes, but with such a comparative scarcity of sap, that only one lobe is developed, whilst the other continues in a rudimentary form. This second explanation is very likely to be in acordance with the observations of many planters, who firmly believe that the caracolillo is mostly found on the ends of the branches and old trees.

The caracolillo grain has no plain side to it, as it is all curved up and shows a section entirely distinct from the normal shaped grain which is called "planchuela."

The defect which gives rise to the formation of the caracolillo, does not show outwardly and cannot be at once discovered. At the same time, with a little attention and practice, the berries which contain caracolillo, can be distinguished amongst others of a normal formation.

In the berries which contain two grains, the line which unites the base of the peduncle with the apex of the fruit and which is shown by the scar left by the flower, is always a perfectly straight line, whilst in the abnormally formed berries which enclose the caracolillo, this line is notably curved. At the same time, there is no advantage in separating this class at the time of taking off de crop as the separation can be carried out with more ease and perfection, after preparing for the market.

The gathering of the fruit is a very simple operation, but at the same time, it is very delicate and demands the greatest vigilance on the part of the laborer. The precautions which must be taken in gathering are very few, the principal being that of only collecting the perfectly ripe berries, to be followed by measures for the preservation of the berries which are still green, as well as the peduncles of the fruit.

This last precaution which is so often neglected, is very important, as if these peduncles are cut at the point of issue from the branch, a wound is formed which scars over, but will not permit the subsequent development of blossoms.

The perfect maturity of the fruit is known by its assuming a bright scarlet color, which in some cases becomes slightly dark. Only these berries ought to be picked and those which have not reached this condition ought to be reserved for a second or third picking. The laborers employed ought to be provided with a basket in which to place the fruit picked during the day, so that when the day's work is done, they can carry them to the storehouse. In this country no use is made of a ladder for picking, but we should strongly recommend its use,

especially when the trees have reached any height, as it prevents their suffering injury.

During the picking season, the planter must organize a strict vigilance over the pickers, both with the object of preventing any injury to the trees and the picking of unripe berries, as well as to prevent the picking being done in a disorderly manner and from trees which have not been designated; other wise, the picking is a very simple matter.

According to Vam Delden Laerne, in some of the estates in Brazil the picking is done in a very rapid manner. For this purpose pickers take hold of a branch by its tip and closing the other hand on the branch, pass it along the entire length, so that berries and leaves fall together to the earth. It is easy to understand that this is an entirely vicious and unpardonable proceeding.

MANURES.

The greater part of our planters labor under the idea that the coffee tree requires no manure, especially when the plantation has been established on recently cleared forest land; others who do not belong to that group, consider manure to be useful and apply it when possible, but there are very few who thoroughly comprehend the great necessity of furnishing the plant with. the food that it daily consumes, and of which it would be eventually deprived without the use of manure.

The first part of this chapter will be of use to those persons who do not employ manures, as we propose to show clearly the reasons for such a necessity.

Assuming the normal production of a tree at eight ounces, and that the trees will be 2½ metres distant from each other, we find that we have 1,560 plants in one hectare of land, reserving 250 square metres for walks and roads. Under these conditions, a hectare would produce 780 libs. equal to 358.8

kilograms of clean coffee in each year, or say, 1,392.14 kilograms of ripe berries.

From these figures we will now calculate the annual consumption of the most important elements, which are phosphoric acid, potash and azote. These elements are found distributed throughout the beans, the pulp and the parchment; but as the two last can be returned to the soil, it is plain that what is positively extracted from it is the substance of the bean itself.

Bearing in mind the quantities shown in the last table of analysis which we presented in speaking of the chemical composition of the coffee, we are in a position to calculate the contents of 1,392.14 kilograms of berries and 358.8 kilograms of beans, as well as the elements remaining in the pulp and parchment.

Table which shows the elements consumed in one hectare of land.

	Consumed by 1,392 14 k. of berries.	Exported in 358.8 k. of coffee.	Remaining in pulp and parchment.
Phosphoric acid.....	1.426 k.	1.039 k.	0.387 k.
Potash.....	10.309	5.191	5.118
Azote.....	8.558	6.027	2.531
Lime.....	1.736	0.529	1.207

The figures shown in the second column of the above table clearly indicate that the berry annually extracts from the soil 1.039 kilograms of phosphoric acid, 5.191 kilograms of potash, 6.027 kilograms of azote and 0.529 of lime. Now, it is well known that the fertility of the soil is in direct proportion to the amount of plant food that it contains, and we can understand that if from an average fertile soil we annually extract such considerable amounts of phosphoric acid, potash and azote, its productive capabilities, and consequently, its fertility will constantly diminish.

As far as regards the azote, the impoverishment will be slow

on account of the restitution which is obtained without the employment of manure, as has been demonstrated by the continued experiments of Schloesing and Bertelot; but with respect to the phosphoric acid and potash, there is no natural restitution, and consequently, the impoverishment is more rapid and pronounced. The chemical analysis can even give us a very fair guide to the degree of impoverishment suffered by the soil.

If we bear in mind the analysis of the soils in which coffee is generally cultivated, we can base our calculations on the following figures:

One hectare of land.

Area	10,000 square metres.
Mean depth of soil	0.75 metres.
Density (weight of a cubic decimetre)	2.33 kilograms.
Weight of the arable land per hectare under these conditions, the volume being 7,500 cm.	17,457 kilograms.
The richness of the soil in phosphoric acid will be	0.6657 por ciento.
The arable layer on one hectare of land will only contain	4,9260 kilograms.

of phosphoric acid, so that if there were no reserve in the sub–soil and no manure applied, a periodical extraction of 1.39 kilograms would completely exhaust the supply within a short time. The same calculations can be made with respect to the potash, the azote, etc.

These losses have not really taken place in practice, because the sub–soils always hold a certain proportion of element in reserve, which they continually furnish to the plant as required, but there can be not doubt of the impoverishment of the soil and the diminution of crops.

The fertility of the soil is in proportion to its richness in nutritive elements, and many scientific agriculturists consider phosphoric acid as the first thing to be looked to in determining the degree of fertility, always bearing in mind other con-

ditions; such as the depth of the soil, facilities for drainage, etc. We have above indicated the very small proportion of this element contained in ordinary soils and the great quantity consumed by the plant, noting at the same time, that we have only taken into account the quantity which is exported and without mentioning that which is required for the growth and development of the plant. We thus find, that if the fertility of the soil is in proportion to its richness in phosphoric acid as shown by the analysis, we can very well represent it by the algebraic formula F = C. E. R., in which F represents the fertility, C the coefficient depending on the physical qualities of the soil, E the depth of the soil and R its richness in phosphoric acid, potash and azote.

It is clear that if R annually diminishes, F must also diminish, and consequently, it may turn out that it is exhausted when R equals zero. In order that F should remain constant, it is necessary that C. E. R. should preserve the same value. C remains constant in any case, the same as E; R dimishes in proportion as crops are produced, and consequently, in order to maintain the same degree of fertility, it is indispensably necessary that the richness of the soil in nutritive elements should remain constant. This is a wise law of restitution which was discovered by Liebing, and explains the results obtained by the employment of manures.

Manure can be considered as the raw material of agricultural production; once placed in the earth, which may be called the manufacturing machine, it is promptly drawn to the interior of the plant, in which, by means of transformations closely related to vegetable life, it is converted into marketable fruit. No industry can obtain products without raw material, and agriculture, like other industries is a constant consumer of such material. The rational employment of manures is subject to scientific knowledge, and can never give the desired results if placed in the hands of an empirical practitioner.

The above will explain the reason why before supplyng the

plant with the manure which is considered necessary, it is essential to investigate the elements which are wanted by that plant, their quantity and in what state of assimilation. These studies have given origin to long and minute analyses, which have clearly shown the substances that assimilate with vegetables.

In the article treating of chemical composition, we have given a table which shows the mineral substances required by the coffee tree, amongst which figure carbonic acid and azote. The mineral elements and azote are the only ones of which we need take any notice, as the gaseous elements, such as hydrogen and oxygen as well as carbonic acid, are found in abundance in the atmosphere and water, and can never be advantageously introduced in the manure.

We therefore, find that the elements which we require to study are; phoshoric acid, sulphuric acid, chlorine, lime, magnesia, potash, soda, oxide of iron, silica and nitrogen. Amongst all these elements, some are plentiful in the soils themselves, such as silicic acid, oxide of iron and sometimes lime. Others, such as chlorine and soda, although not found in the soil, ought not to trouble the planter, whilst others are of such importance that vegetation is impossible without them, such as: phosphoric acid, potash and azote; and as regards magnesia, its importance is in proportion with that of phosphoric acid.

Each hectare of land has an annual consumption of 1.0390 kilograms of phosphoric acid, 5.1910 of potash, 6.0290 of azote and 0.529 of lime. According to these figures, if we only limit ourselves to the restitution of the quantities consumed by each crop, without attempting to enrich the soil, we will employ a manure which will contain the above relative proportions of phosphoric acid, potash and lime.

The restitution of azote cannot conveniently be made in the proportion of 6.0270 kilograms per hectare; firstly, because it would be too expensive, ann secondly, because the natural restitution (nitrification, absorption of atmospheric ammonia, etc.)

renders the impoverishment less sensible. Many people think that the employment of manures largely diminishes the profits, but we only need to calculate the value of the crop over one hectare of land and the cost of restitution, to comprehend that the capital invested in manures is amply compensated.

Three hundred and fifty-eight kilograms of coffee, or say 777 lb, which are produced by each hectare, are sold for $ 156, assuming the price to be 20 cents per lb.

In order to calculate the cost of restitution, we will cite one of the articles published by the "Revista Agrícola" under the title of "Manures," and which reads as follows:

"The highest prices quoted in Europe for the available elements of manure, are as follows:

Soluble azote	$ 0.50	kgm.
Organic azote	0.34	,,
Phosphoric acid	0.12	,,
,, ,, in the condition of tribasic phosphate	0.08	,,
Potash	0.10	,,
Lime, (variable)	0.03	,,

We thus find that the cost of restitution will be:

Phosphoric acid	1.0390	kgm.	$ 0.12
Potash	5.1910	,,	0.52
Azote	6.0270	,,	3.01
Lime	0.5290	,,	0.02
			$ 3.67

Three dollars and sixty-seven cents would thus be the expense of providing the manure for restitution, always providing that it was a total restitution with respect to azote. If this last element is reduced to 1.42 kilograms in quantity, its expense would amount to 77 cents and the cost of manuring a whole hectare would only amount to $ 1.36. We would recommend the employment of mineral manures, mixed with the residium from the treatment of the berry and the refuse of the banana, which contains a great deal of valuable matter.

We can also strongly recommend the employment of the following manure:

Super-phosphate	30	kilograms.
Nitrate of potash	40	,,
Nitrate of soda	10	,,
Sulphate of lime	20	,,
	100	

Each kilogram of this mixture contains:

		PhO^5	KO	Az	Ca O.
Super-phosphate	300 gs.	63 gs.			83 gs.
Nitrate of potash	400 gs.		186	55	
Nitrate of soda	100 gs.			16	
Sulphate of lime	200 gs.				83 gs.
		63 gs.	186	71	165 gs.

If we therefore, distribute each kilogram of manure amongst fifty trees, each one of them will receive:

Phosphoric acid	1.26 gs.
Potash	3.92 ,,
Azote	2.42 ,,
Lime	3.30 ,,

and each hectare of land will requiere 31.2 kilograms of the composition. Calculating the quantities of phosphoric acid, potash, etc., which are exported in 230 grammes (8 ozs.) of coffee, which is produced by each tree, we obtain:

Phosphoric acid	0.666 gs.
Potash	3.329 ,,
Azote	3.863 ,,
Lime	0.339 ,,

quantities which, with the exception of the azote, are smaller than those furnished by the manure.

The restitution of the refuse of the berries, ought not to be taken into consideration, because it adds nothing new, but only returns what had already been taken from the ground.

With respect to the banana tree, we find that it furnishes an important amount of useful substances. Each hectare of land will annually furnish 8,000 kilograms of trunks and leaves, which contain 82.40 kilograms of mineral matter and 8.72 kilograms of organic azote, or say, 6.54 kilograms of soluble azote (Lawes & Gilbert). The useful elements are found in these proportions:

Phosphoric acid	1.04	kilo.
Potash	23.78	,,
Lime	14.24	,,
Soluble azote	6.54	,,

These quantities are worth taking into consideration.

What we have said up to this point only refers to the restitution or return of the elements extracted from the soil. When the planter is desirous of increasing his production by means of manures, the amount to be employed will not be the same. On this subject, it would be difficult to lay down any absolute rules, as their application, if fruitful of good results at times, would be injurious in others. The employment of manures in agriculture is strictly subordinate to scientific operations which have to be specially undertaken for each case. It is necessary to know the chemical composition and physical qualities of the soil which is to be cultivated, before any well founded opinion can be given; and even further, it is necessary to make experiments on a small scale with different kinds of manures under different conditions.

This is an experience that every planter must go through on his own account, as the investigation of the manures and the quantities to be employed are a special study for each locality.

The manure has to be scattered near the foot of the tree, opening a circular ditch in which the manure is scattered and mixed with earth so as to give it a uniform distribution. The most convenient season for this operation, is the beginning of spring, that is to say, after the picking of the crop, as by that time the trees have renewed their vitality and actively entered

on their vegetative functions, so that the absorption is more energetic.

We will close this chapter by copying the instructions which George Ville give for the preparation of fertilizing compositions. "When the planter himself prepares the mixture of the elements (and that is a great deal the best plan), he must take care that it is thoroughly done, in order that the small roots of the plant shall find the different agents within their reach, whose good effects greatly depend upon their similtaneous presence.

It is necessary to procure the acid phosphate of lime several months before preparing the mixture. Immediately after being prepared, this material presents a pasty consistency that renders the operation of mixing difficult; but at the end of two or three months, it dries and can be easily powdered.

The preparation of the mixture is carried out in the following manner: the phosphate of lime is first spread over the ground and covered with a layer of chalk. Twenty-four hours after, it is mixed by turning over with a shovel and the two materials then remain heaped up for one or two days. After this, the composition is newly spread over the ground and the other substances which enter into the manure are added. The incorporation with the original composition, is made by giving the mass a good turning over with the shovel and by breaking up the clods with a wooden hammer, similar to the maul which is used for rail splitting.

Once the materials are well incorporated, the mixture is sifted, and then given another good mixing with the shovel until it is perfectly homogeneous."

PREPARATION FOR THE MARKET.

Once the fruit has been picked, and in order to give it a market value, it requires to undergo several successive operations which give it the due preparation.

We have already shown that the cleaned coffee is the albumen of the fruit of the coffee tree. This fruit contains one or two grains, folded in a double parchment membrane and a meaty pulp.

This pulp, when the berry has been newly picked, contains a certain amount of humidity and is easily separated from the rest of the fruit. It can be dried by a long exposure to the sun, or simply to the air, when it assumes a dark color and a wrinkled appearance, becoming at the same time, very hard, and in this condition it is difficult to separate from the grain.

The coffee berry ought to be treated immediately after picking, for the reasons that we will give further on, but at times this cannot be done and it is necessary then to operate on the dried berries. Different methods of treatment are employed according to whether the berry is fresh or dry. In the first case, operations are commenced by depriving the fruit of the pulpy envelope which encloses the two grains and the parchment. This very easy operation is effected by means of what are called pulping machines, to which we will refer later on.

Once the grains are freed from the pulp, they are still held within the parchment membranes, and it is necessary to free them from these. This is an operation which cannot be at once entered into, as the membranes keep the berries closely folded on the convex side, and penetrate into the furrows of the grain between the two plane sides; so that the separation can only be made by tearing this membrane, which is very difficult to do inmmediately after the pulping process. After passing through the pulping machine, the coffee is damp, and the parchment is surrounded by a mucilaginous substance which makes it very slippery. In this condition it would pass through the machines employed to thrash out the hulls, without any result whatever being obtained.

In order to work sucessfully, it is necessary to comence by washing the parchment until it loses all the mucilage, after which it is thoroughly dried so as to make it brittle. In this

condition it is passed through the hulling machine, which delivers it entirely freed from the parchment. After this, the bean goes through the operations of polishing, cleaning, selecting, etc.

When the coffee is treated in a dry condition, the operations become much easier, as the coffee itself throws off the dry pulp which has an appearance of a shell, and at the same time, breaks the parchment envelope that holds the grain. The cleaning and selecting operations are carried out immediately after.

At first sight it would appear that the second method is the most advantageous, and it is the one which was originally employed, and which is actually preferred in almost the entire coffee zone of Mexico. Nevertheless, this method has many very great disadvantages, as the product loses a good deal in quality, and consequently, in commercial value.

When the fruit is dried in its original form, the pulp undergoes on its first exposure to the sun, a fermentation which greatly injures the grain and deprives it of its aroma, whilst it assumes a yellow color and very often breaks out in spots. When dry, the berries are put through the huller, and however perfect this machine may be, it often breaks the bean and always scratches it. The grain that is thus obtained is both smaller and lighter, circumstances that greatly perjudice the cultivator.

On the other hand, the process of pulping has every advantage, and we therefore, cannot do less than recommend its employment by all intelligent planters. It is true, that a plant of this character is much more costly, but there is no question as to the improved results that are obtained.

The primitive process that is still employed by poor planters or by those who oppose progress, is based on hulling the coffee in a dry condition, and these men will never abandon this antiquated system until circumstances permit them to employ machinery.

If machinery is not employed, this is the only process pos-

sible, but when the planter can set up a good plant, he ought certainly to select one adapted to the pulping process. A perfect plant of the most modern type and with the latest improvements can now be easily obtained, as great advances have been made of late years in the machinery dedicated to this industry.

Pulping. This first process is now carried out with machines that are called pulpers. They are found of different patterns, sizes and prices; but they all work on the mechanical principle of rubbing the fruit against roughened surfaces, with knobs that tear the parchment and pulp from the bean.

The most important patterns are those made by the English manufacturers, John Gordon & Company, whose work we have had occasion to see and greatly appreciate. These English machines are composed of a hopper into which the picked berries are placed, and from which they are drawn by a current of water and passed between a cylinder covered by a copper plate full of studs and a metal plate which is held against the cylinder by means of a rubber sheet. The mechanism is exceedingly simple and the result is entirely satisfactory. The Gordon factory manufactures several patterns of this class of machinery suited to the requirements of plantations of different sizes. The smallest pattern, which is called the "Jamaica," is a hand pulper, suitable for working in small plantations, and it has a capacity of 20 fanegas of berries per hour. (Fig. 9).

The patterns A and B (Fig. 10) have a capacity of 50 to 60 fanegas respectively; their interior works are much more perfect and better finished, whilst the machines are operated by either hand or steam power.

The Brazil pulper, which has given excellent results, consists of a pulping cylinder, a hopper and a galvanized iron feeder with a rotatory sieve and a set of elevator buckets. The berry is emptied into the hopper and passes to the cylinder which separates the envelope from the grains; these afterwards pass through the openings of the sieve, whilst the berries which

have not been deprived of their envelopes are deposited in the elevator feeder along with the pulpy residue. This pattern is constructed to be moved by water or steam power and has a capacity of 60 to 70 fanegas per hour.

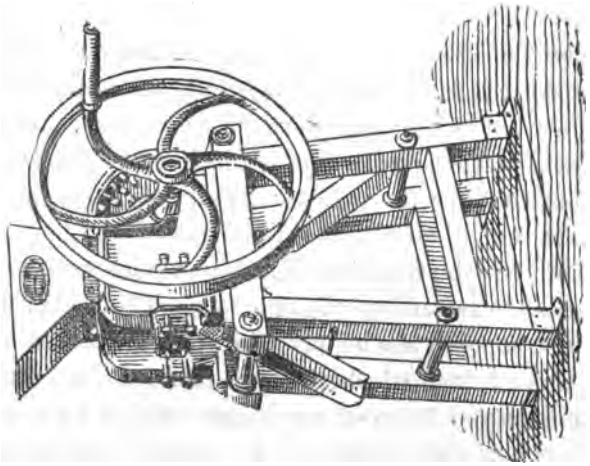


Fig. 9.
"JAMAICA" PULPER.

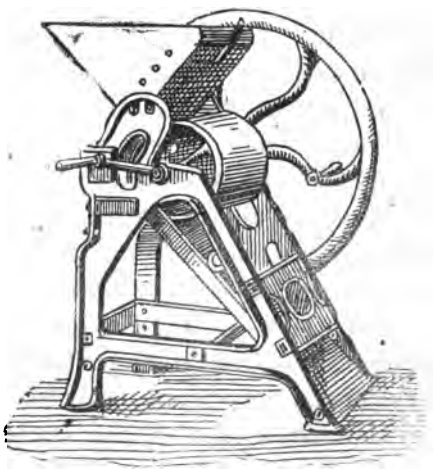


Fig. 10.
GORDON PULPER.—A. PATTERN.

The combined Gordon machine (Fig. 11) is constructed to crush and pulp coffee berries by means of crushing cylinders, and gives the very best results. It is provided with a hopper,

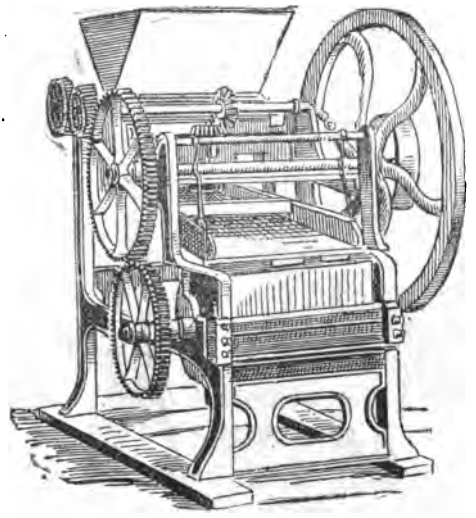


Fig. 11.

COMBINED GORDON PULPER.

sieves, etc.; it is adapted to work by either water or steam power and has a capacity of 80 to 90 fanegas per hour.

The double coffee pulper is composed of two cylinders, a hopper, a feeder, a sieve and a set of elevator buckets. This is the most complete of the Gordon pulpers and is suitable for large plantations as it has a capacity of 100 to 150 fanegas.

All the Gordon pulpers can be fitted with the Dieseldorff patent graduator, the object of which is to economize water and separate the foreign bodies that might injure the lining of the pulping cylinder. It is equally adapted to the use of large and small quantities of water. It acumulates on the cover all the stones, sand, etc. which can afterwards be emptied out

at the end of the day's work. Fig. 12 shows a Gordon pulper fitted with a Dieseldorff graduator.

The American pulpers manufactured by the house of George L. Squier, also give very good results and are suitable to the requirements of small and large plantations. This manufactu-

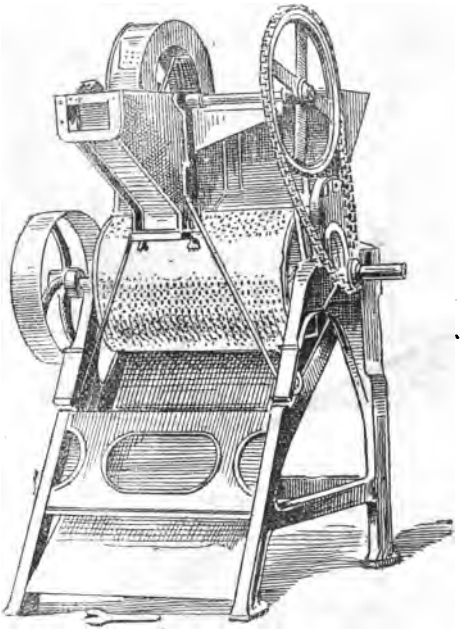


Fig. 12.

GORDON PULPER WITH DIESELDORFF.

rer constructs machinery with discs and with cylinders. The improved disc machines are of a simple and lasting pattern. The firm manufactures four sizes with one, two, three and four discs, and the machines are adapted to working by hand. Their capacity is: the single disc machine, 1,050 litres; the two disc machine, 2,100 litres; the three disc machine, 3,150 litres; and the four disc machine, 4,200 litres.

The improved cylinder machines are exactly similar to those manufactured by Gordon, and Squier makes them of two sizes. The Nº 1 machine with a capacity of 1,050 litres per hour, is to be worked by hand, can be operated by two men. The Nº 2 machine, can only be worked by horse, water or steam power, and has a capacity of 2,100 litres per hour.

The pulping must be done immediately after the berries are picked, or within ten hours after the picking, as otherwise the fruit will ferment and injure the bean. Some planters adopt the plan of steeping the berries in water tanks, from which they are passed to the machine by the force of the current. This is a good method, but it presents the difficulty of requiring a large quantity of water. It is, therefore, preferable to carry the berries to the hopper in the machine by a special channel, and the water by means of a feed pipe, as in this way, it is possible to control the amount of water used.

Washing. When the bean is cleaned from the pulp in machines that have no sieve, it comes out mixed with the refuse pulp and requires separating. This can be done by means of a special sieve, or as is preferred by many of our planters, by means of settling tanks. The sieves best adapted to this process are table sieves.

The sieves have the advantage of giving a continuous operation, but they suffer from certain defects, amongst which the principal is, the imperfect nature of their work.

The settling tanks labor under the disadvantage that the refuse cannot be separated until the whole of the berries have gone through the pulping process; but a the same time, they present the advantage of giving the coffee what may be called a preparatory washing, which is a great help to the subsequent washings. The employment of these tanks always requires a considerable supply of water. They are arranged in the same manner as the washing tanks, which we will treat of further on.

Once the bean is separated from the pulp, by one process or another, it undergoes one or more washings, which, as we

have already said, are intended to separate the mucilaginous substance that adheres to the parchment envelope. These washing are carried out in tanks or better still, by means of machinery.

The employment of washing tanks presents the same defects as that of the settling tanks, but nevertheless, as the washing machines have not yet come into general use, we will give a description of the most convenient way of arranging the tanks.

The capacity of the plant which is set up with this object, ought to be in proportion to the maximum quantity of coffee which may be passed through the pulping machines each day. Three tanks of equal capacity are constructed, and when the ground will allow it, at different levels, so as to give them an arrangement somewhat similar to that which is shown in Fig. 13. As can be seen, the walls are well elevated above the surface of the ground, as otherwise, there would be a great deal of difficulty in emptying the liquid and extracting the beans. They ought to be built of the best material obtainable, and it is especially necessary that the sides and bottom, should be perfectly smooth on the inside. The best materials for their construction, would be found in artificial stone, cement, etc.

These tanks communicate with each other by means of properly arranged sluice-gates. The water ought to be introduced by means of taps proportioned to the capacity of the tank, and they ought to be arranged so as to be emptied whenever desired. This result can be easily obtained by placing plugs in the bottom which can be opened from the outside, and covering these plugs with a double iron grating, so as to prevent the loss of beans.

The washing is done in these tanks in the following manner: once the pulping operation is concluded, the grain is left heaped up in the first tank and slightly damp, for four, five or six hours, the object of this being to initiate a slight fermentation which facilitates the loosening of the glutinous substance. When this stage is reached, the tank is filled up with water

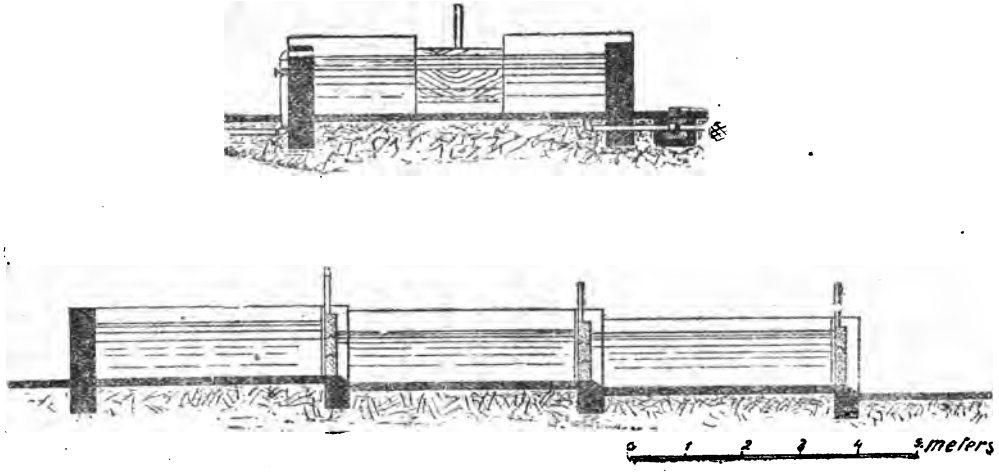


Fig. 13.
WASHING TANKS.

and two or three men give the grain a thorough agitation with shovels, allowing the liquid to flow freely. The grain is thus carried to the second and afterwards to the third tank, where it undergoes the same treatment, and is taken out of the third after it becomes perfectly clean. The washing tanks give the best results and only present the difficulty of being costly and requiring a considerable quantity of water. We have already said that the size should be proportioned to the amount of work required, and it can be calculated on a basis of 244 cubic decimetres in each tank per 100 lb. of beans.

With the object of facilitating the work and shortening the time of washing, the Squier factory has placed a washer on the market which has given very good results. The American washer is composed of a cylindrical iron box, which turns on a horizontal shaft fitted with properly arranged teeth; this agitates the coffee within the current of water circulating inside the cylinder. It can wash 150 quintals in 24 hours. When this machine is employed only one tank is required and by using two washing tanks at different levels, very good results are obtained. After washing, the coffee requires to be dried.

Drying. In this country and on the most of the plantations in Central America, the coffee is dried by the sun on platforms specially constructed for this object. These drying platforms are extensively employed amongst the planters in spite of their many defects. As the picking season comes in the months of November to January, as we have already stated, the drying operations have to be carried out under the worst conditions, the days being frequently damp and cloudy, which greatly delays the operation. Nevertheless, these drying platforms are greatly preferred in this country, for drying the coffee.

The construction of these platforms is very simple, as the only condition required is that they shall furnish a continuous floor which is exposed to the sun and air. Their area varies in proportion to the quantity of grain that is to be exposed, and the average is based on a calculation of three square metres

of surface for every hundred pounds of grain in the parchment. They are generally arranged in a similar manner to the thrashing floors, and the shape preferred is square or rectangular.

In order to construct the drying floors, it is preferable to select a level piece of ground, or one with a very slight slope, and when the rains are frequent during the picking season, it is not only convenient, but necessary, to lay the pavement of the drying-floor with a slope, so that the water will immediately escape through the drains which ought to be conveniently arranged for that purpose.

The pavement is generally laid with bricks, but better results are obtained by the employment of artificial stone or asphalt. When the drying-floor is built of brick, care must be taken that the bricks employed are perfectly burnt, or at least, that they should not be porous. The bricks which do not have these conditions delay the operation of drying through the humidity which they preserve, and besides that, they communicate to the grain a strange and disagreeable odor which can never be got rid of.

The artificial stone does not present any of these difficulties when properly prepared and applied; but when it is not so, it is very apt to break up easily with the rasping of a shovel. The asphalt is undoubtedly the best material, although it comes more expensive.

The operation of drying is one of the most delicate in the whole business, as the quality and color of the grain greatly depend on the duration of the exposure to the sun and the manner in which the operation is carried out. It is always necessary to take care that the coffee forms a layer of six to eight centimetres, and never more. As under this arrangement, the grains which are on the top of the layer receive most sun, it is necessary, in order to obtain an even grade of bean, to turn the berries over as frequently as possible, an operation that on the other hand, facilitates the evaporation of water.

The grain is afterwards removed with the help of shovels or

other implements made for the purpose; these being composed of a long wooden handle, from 130 to 150 centimetres in length, on one end of which is set crosswise, a board of a trapezoidal form. This board which is dragged along the pavement of the drying–floor, carries the coffee grains along with it.

The drying operations are suspended as soon as the parchment skin loses its slippery character and becomes brittle, which change takes place in seven or eight days of good weather, although it is sometimes prolonged to fifteen and even more days when the weather is damp and there is little sunshine. In hot climates, the dew is always abundant, and care must, therefore, be taken to protect the grain against its influence by covering it over with mats during the night.

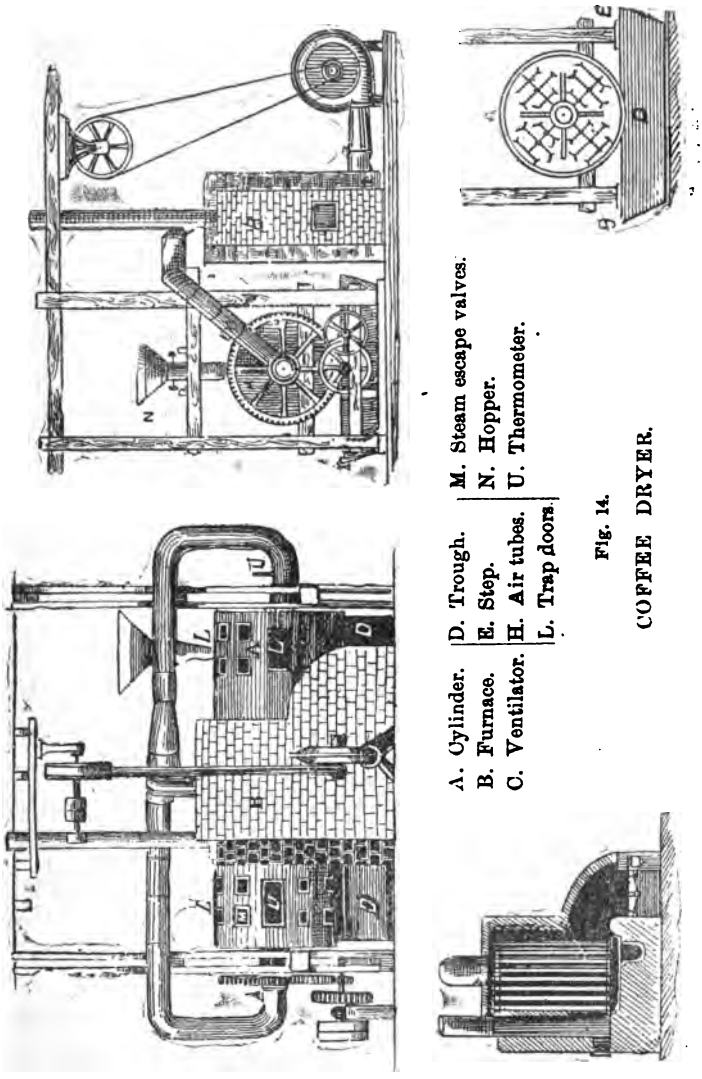
The results obtained by the employment of a drying–floor are good; but they are always tedious and sometimes dangerous or which reason, it would be very desirable that our planters; should make up their minds to employ drying stoves and apparata, which greatly facilitate the work. We have not found that drying machines are used in any part of the Republic and we therefore, recommend them very strongly.

The drying machine is composed of a cylinder A, a heating oven B and a ventilator C. (Fig. 14).

The cylinder is divided into four compartments which are alternately charged with equal quantities of grain, so as to give it a greater equilibrium and facility of rotation. The apparatus is charged through the apertures L, and with a view to facilitating this operation, a sliding hopper N is provided. Once the cylinder is charged, it is put in motion at the same time as the ventillator, and the fire is then started in the furnace.

The man in charge of the machine has nothing more to do than to look after the fire and see that the heat never goes above 66° C. on passing the thermometer. The hot air is divided on penetrating the cylinder into more than 34,000 small currents, which go through with great velocity and gradually carry off the humidity, the rapidity of the operation being in-

creased or diminished according as may be desired. The cylinder does not give more than two revolutions per minute.



A. Cylinder. | D. Trough. | M. Steam escape valves.
B. Furnace. | E. Step. | N. Hopper.
C. Ventilator. | H. Air tubes. | U. Thermometer.
L. Trap doors.

Fig. 14.

COFFEE DRYER.

The ventilator drives a great current of air, which, passing through the heating tubes, acquires the necessary temperature.

When the coffee is considered sufficiently dried, samples can be taken out by the openings L without any necessity for stopping the machine. In order to discharge the cylinder, it is only necessary to open the little doors at L and the grain falls of itself into the trough D. The construction of the furnace is of the simplest character. The force that is required to operate this machine is very slight and its price is comparatively low.

On the other hand, the advantages of these drying machines with respect to the drying–floors, are very evident. A drying–floor is expensive to build, it dries less coffee and that in a very imperfect manner, whilst it is expensive in its operation on account of the number of people employed.

With the drying machine a hundred quintals can be dried in twenty–four hours, and they are made with a capacity of 40, 70 and 100 quintals.

Besides these heat drying machines, centrifugal dryers are coming into use. The centrifugal (Nº 15), which is especially constructed for this purpose, does not deliver the coffee in a perfectly dry condition, but it can be advantageously employed in combination with the drying floors or machines, and especially when the planter works with the former.

The "American" machine carries off 60 to 70 per cent of the humidity with only twenty minutes of work, and greatly decreases the time required for the complete drying. The box A of the machine is built of brass and well secured to the shaft, which as can be seen it the drawing, carries on its upper end the pulleys required for the transmission of power. These pulleys ought to work with a minimum velocity of 700 revolutions per minute. The box can be discharged throught some traps in the bottom, and its movement can be stopped by means of the brake U. This box has a capacity for 250 lb. of coffee, and only requires twenty minutes to drive off the humidity. It can dry 60 quintals in twelve hours and requires four horse power to move it.

Hulling. When the coffee has been properly dried, either on

the drying–floors or in the machines, it is carried to the hulling machines in order to remove the parchment skin. It is not necessary to do the hulling inmediately after collecting the grain from the drying–floors; if for any reason it should be more con-

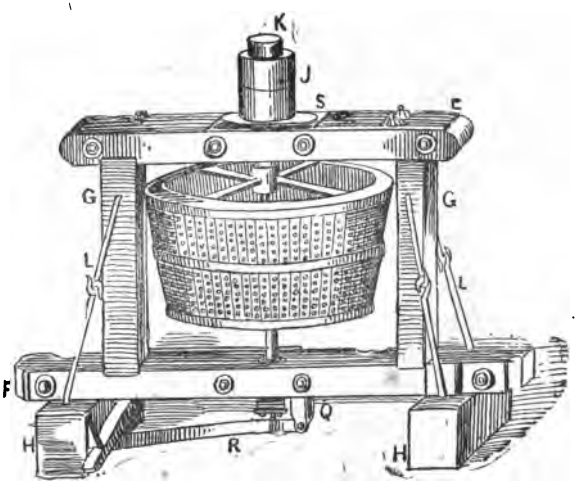


Fig. 15.
"AMERICAN." CENTRIFUGAL DRYER.

venient to store it, it can be stored in the hull as this will perfectly protect it against all injury.

The operation of hulling is rapid and simple, and requires to be executed with machinery. The hulling machines are composed of a cylinder which is the principal part; of a charging trough, or hopper; of a channel to give an outlet to the grain and of the other necessary pieces to adjust the machine and to give it motion.

The hulling cylynder is made of metal with a fluted surface which revolves in the interior of a cylindrical and adjustable cover, also made of metal and fluted on the inside. When the grain of coffee is rubbed betiveen the side of the cover and the surface of the cylinder, it gradually frees itself from its parchment skin. The opening through which the grain enters is placed on

one side of the cylinder and the outfall is generally placed on the opposite side, so that the grain is required to pass along the whole length of the hulling cylinder. The differences which will be found in the various hullers on the cylindrical system, only arise from the different arrangements of the fluting and the manner of adjusting the outside cover.

There are also disc hullers built for dry berries, such as the Smout Huller (Fig. 16). These machines are fitted with two fluted discs of which one is fixed, whilst the other is moveable and can be adjusted by means of a pressure screw.

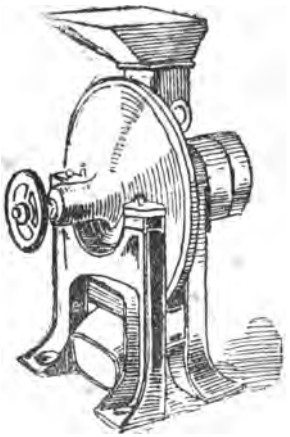


Fig. 16.
GORDON DISC HULLER.

Like the pulping machines, there are many hullers on the market, the principal being those manufactured by Smout, Squier and Engelburg. The first which are of excellent construction and give magnificent results, are the best. All those which we have had an opportunity to see, execute their work in a perfect manner. Gordon & Co. of London, construct two models of these machines. One is simple and the other is a combination of that machine with a suction ventilator. The simpler model is shown in (Fig. 17), and can easily hull 50 quintals of coffee in twelve hours. The combined model (Fig.

18) has the great advantge over the other of delivering the coffee cleaned and free from dust and refuse, in condition to be

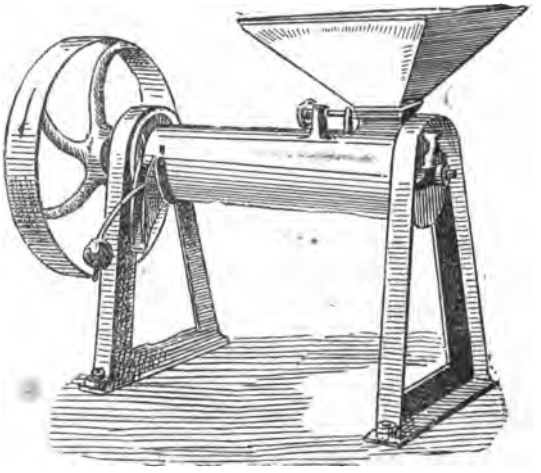


Fig. 17.
SMOUT HULLER.

at once passed to the separator, thus avoiding the use of a separate fan-mill.

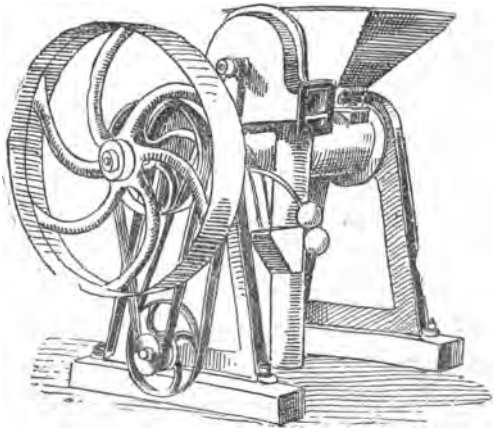


Fig. 18.
SMOUT COMBINED HULLER.

From the very simplicity of their mechanism, these machines are very easily managed, and the only thing requiring arrangement is the feeding of the grain, which can be done by means of a screw on the side of the hopper, whilst the interior pressure is governed by the counter-weight shown in the figure. The Smout hulling machines were awarded the gold medal at the Antwerp Exhibition of 1885.

The Squier hullers have given as good results as those manufactured in England. This firm builds them of many patterns, but the principal ones are the "Buffallo" Huller No. 6, the "American" No. 2, the "Automatic" Huller No. 3, and the Huller and Polisher.

The "Buffallo" huller (Fig. 19) is a simple and cheap machine, but a good worker. It works perfectly with coffee in the hull or with dried berries and can easily be arranged to polish the beans. It has a capacity of 8 quintals per day and requires a force of 1 H. P.

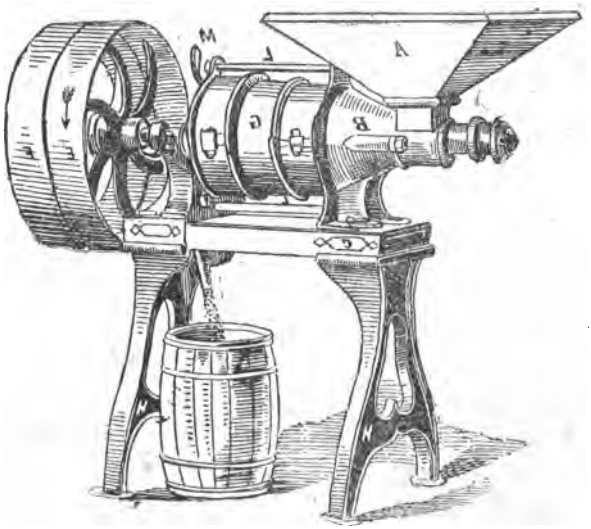


Fig. 19.

BUFALO HULLER Nº 6.

The "American" huller has a capacity of 20 quintals in twelve hours, and can be recommended as a good machine which delivers the coffee in a polished condition, and can work up coffee in the berry or in the hull. We have not had an opportunity of seeing it work, but several planters have highly recommended it.

The "Automatic" huller No. 3 (Fig. 20) is only adapted for large plantations, as it can easily work from 70 to 80 quintals of coffee per day of twelve hours, turning it out with the degree of polish that may be desired.

This machine is composed of a hulling cylinder L similar to that of the "American" No. 4, and a polisher M of the same system. The coffee in the hull is placed in the hopper A and the pulley J is started, whilst the outfall of the grain is controlled at N by means of the weighted lever V. The grain enters the polisher after passing through sieve C which receives its movement from the shaft H by means of the handle G and the lever V. Part of the hull passes through the sieve, after which it separates and issues at E. The outfall of the grain at B is controlled by the lever and counter-weight V. The degree of polish is graduated by means of the thumb-screws which are shown in the drawing.

On the estate of San Miguelito in Cordoba, belonging to Mr. Pardo, we saw these machines at work and found that they gave excellent results when the feed is properly regulated and the coffee is in the hull, but results were not so good when it was worked with dried berries. This machine presents the difficulty of being rather too complicated to be handled by ordinary workmen, who generally are very ignorant, whilst at the same time, its price is rather heavy.

On the other hand, we can fully recommend the Squier huller and polisher (Fig. 21), which is largely used in Uruapam, Colima and Veracruz. This machine which executes as good work as No. 3, is simple and on account of its price, better adapted to small plantations. It can hull 30 quintals per day

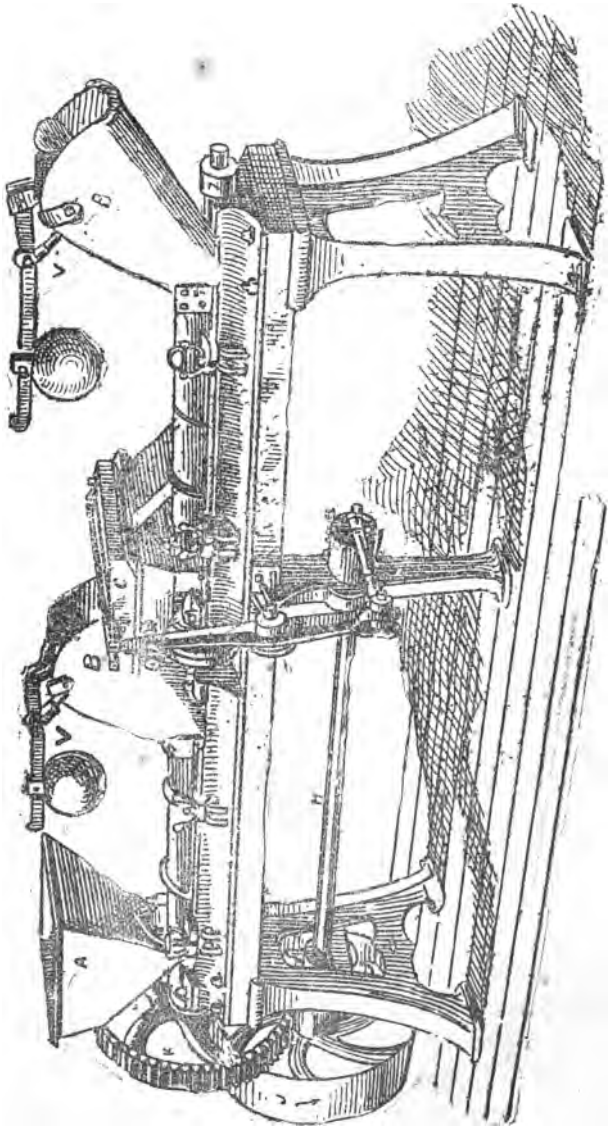


Fig. 20.

SQUIER AUTOMATIC HULLER N°. 8.

without polishing, and is one of the best machines that can be employed.

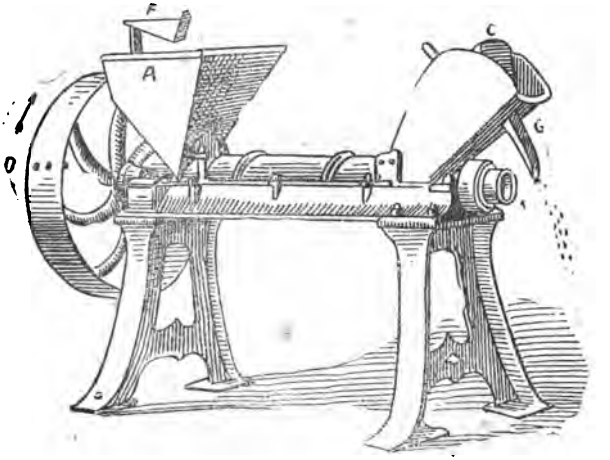


Fig. 21.

SQUIER HULLER AND POLISHER.

The machine made by the Engelburg Huller Co. (Fig. 22), is provided with a suction ventillator, and is of very simple construction, but giving very good results. Like the other machines

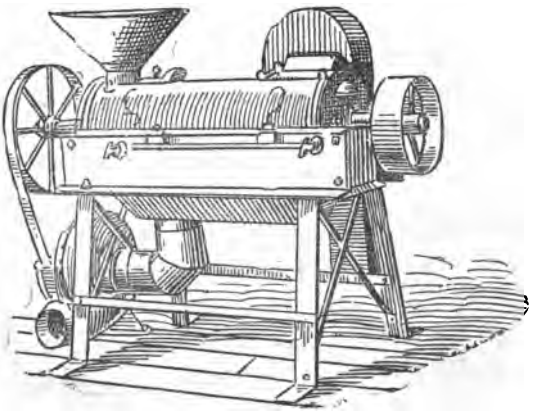


Fig. 22.

ENGELBERG HULLER.

spoken of, it can work with coffee in the hull or in the berry. The No. 1 pattern can easily hull 160 quintals per day, a quantity that no other machine can reach. The coffee treated in this machine, was awarded the only gold medal in the last Exposition in Paris.

The "Champion" huller made by Mason & Bell (Fig. 23) is very simple and does fair work. This firm builds the machine of three sizes, with an iron or wooden frame.

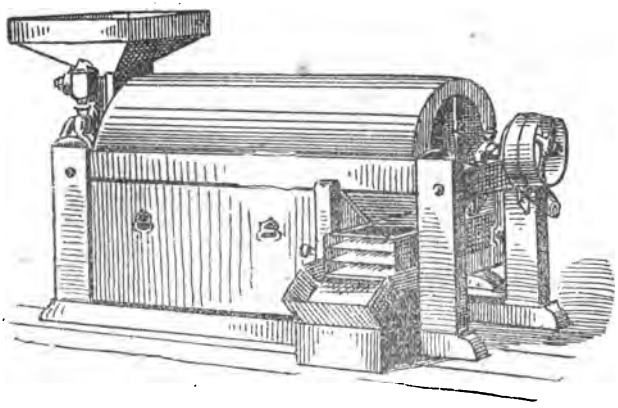


Fig. 23.
CHAMPION HULLER.

Another hulling machine which is on the market, is the "Santa Cruz," but it is very little known in Mexico and we therefore, do not enter into a discussion of it.

The coffee is polished by passing it afresh through the hulling machines. There are also some machines especially constructed with this object. The "Conqueror" drum of the Mason model (Fig. 24) gives very good results. It occupies an area of one square yard and is a yard and a half high; it cleans the coffee of all parchment and can work up from 600 to 1,200 lbs. per hour.

When the planter does not employ hulling machines combined with ventillators, it is necessary in order to finish the hulling, to make use of special machines for separating the grain from the fragments of parchment with which it is mixed.

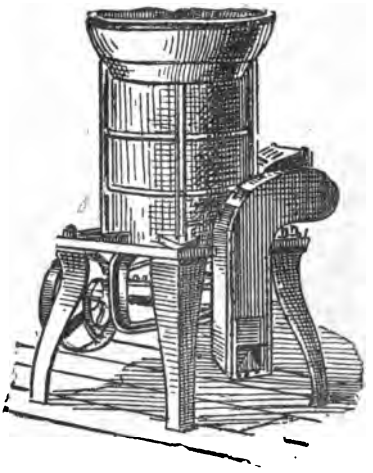


Fig. 24.

"THE CONQUEROR" POLISHER.

Any fanning mill can serve for this purpose, but there are machines especially adapted to it, which besides driving off every class of refuse, also grade the coffee at one operation.

The Squier Separator and Fan–mill throws out the hull, leaving the coffee bean perfectly clean; it also separates the broken and unhulled grains, classifying the rest in two sizes.

Gordon & Co. build several fan–mills, some of which can be fitted to the hulling machines and others which are intented to work by themselves; one of the latter class is the Gordon Fan–mill with a sieve attachment.

The American machines have the advantage of separating the coffee in classes by one operation, whilst with the Gordon machines it is necessary to employ a separator by itself.

The planters who have not much capital, ought to prefer the American separator as manufactured by Squier, as with a comparatively cheap machine, they can winnow and classify their coffee, although they will under any circumstances have to procure a separator for the caracolillo.

It may also be found economical to employ a huller fitted with a suction fan-mill and a Gordon separator, as these, although more costly than the American machines, separate the coffee in seven classes, viz; small and broken grains, *planchuela*, small *caracolillo*, large *planchuela*, medium *caracolillo*, large *caracolillo*, imperfect grains and dust.

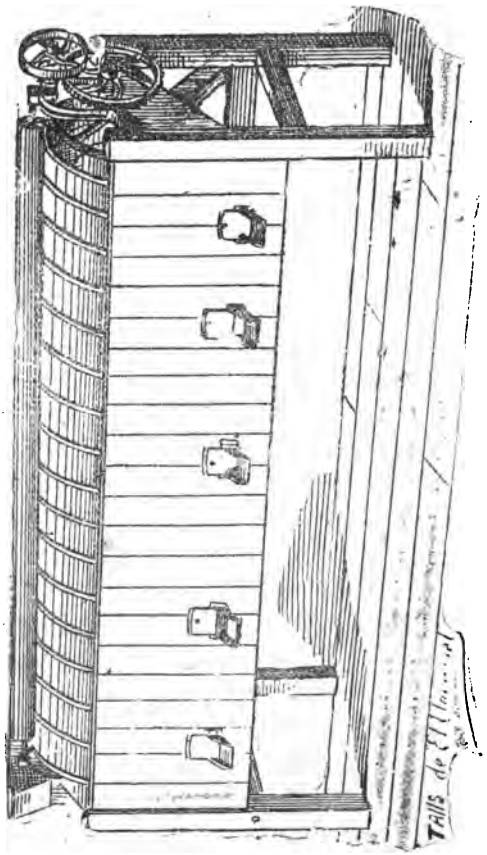


Fig. 25.

THE MASON & BELL SEPARATOR.

The improved separator by Mason & Bell (Fig. 25) is a well made machine which can be advantageosly employed by planters who are not in circumstances to provide themselves with a Gordon separator. It can be worked by hand.

We would especially call the attention of planters to the very great advantage obtained by making a perfect grading of their coffee, and especially when it is to be consumed in a foreign market, where they very properly pay strict attention to these matters. The coffee which is exported, is often sold at very high prices when it presents a good appearance, and especially when it is uniform in size. This is the reason why many coffees from Mexico and Central America, being badly prepared and worse graded, do not find the same demand and high price as others which are of an undoubtedly inferior character.

When American fan-mills are employed, it will be found convenient to separate the caracolillo in the Mocha Separator, as this gives good results. This machine has a capacity for 1,000 lbs. per day and grades the beans in a perfect manner (Fig. 26).

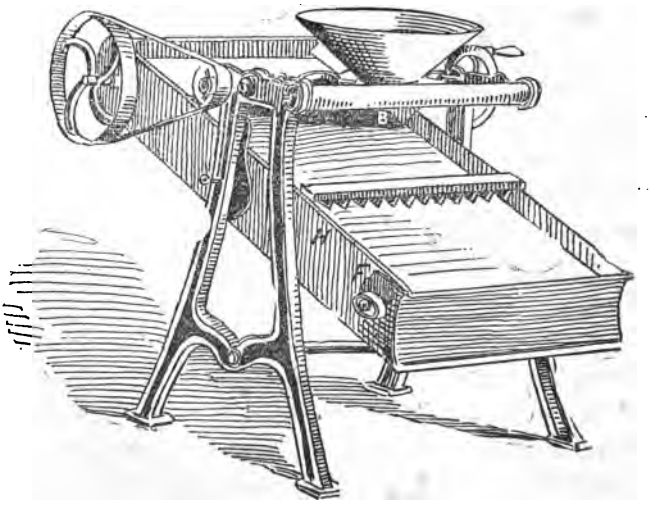


Fig. 26.
MOCHA SEPARATOR.

Having graded the coffee according to classes, it is put into bags holding 100 lbs. each, and is then branded for the market. As the shipments are made in large quantities, it is best to keep it in warehouses provided with good ventilation and pavements, and taking care to put it beyond the reach of humidity and of any substance which would give it a bad odor.

Dry treatment. The dry treatment of coffee is distinguished from that which we have just described by the omission of the washing and pulping processes. As the fruit is picked in the plantation, it is spread out on the drying-floors, with the same care that is given to the coffee in the hull, and especially that it should not be spread in layers more than 2 or 3 centimetres thick, for which reason, it will be understood that the drying-floor should be somewhat larger than that required for drying coffee in the hull.

The fruit can also be dried in ovens. When the outside shell of the berry has assumed the dark color that we have already spoken of, and becomes woody and brittle, it is ready for treatment. The time required to dry the berry is very much longer than that which is required for the parchment hull.

This process of pulping and hulling is carried out with the machines which we have already described, or with others which are especially constructed for this work and which can be easily found in the market. Gordon & Co. construct one which we have seen working with great success (Fig. 16).

The winnowing is in this case a little slower than in the cases above mentioned and it is often found necessary to employ machines provided with a sieve in order to obtain the whole of the product; the other operations which follow are exactly similar to those which we have indicated for the washing process.

Returns. There is a good deal of discrepancy in the reports relative to the returns from a single coffee tree, in its most productive condition, for whilst there are persons who assert that

they have obtained 25 lbs. or more of grain, others declare that they cannot obtain more than half a pound.

In the course of our excursions to the principal coffee producing districts, we have carefully investigated this question, excluding as far as possible, the exaggerations on both sides. Our observations induce us to decide against the reports of very high returns.

Under ordinary conditions, the products fluctuate between four ounces and one pound, and any higher return than that ought to be considered exceptional. In laying down this opinion, we believe that we are adhering to the truth, as we find ourselves supported by persons who are recognized as experts on the subject and who for many years have carefully studied the question.

Without troubling the reader with many names, we will only mention those of Messrs. Ramon R. de la Vega and Hugh Finck, both of whom are well known intelligent planters, the former in the State of Colima and the latter in the District of Cordoba. It would be difficult to obtain any more reliable opinions that those of these gentlemen, who, besides being themselves well instructed men, have had and experience of many years. In his plantations at Tonila, Mr. de la Vega obtains a return of one pound per tree on account of the small size of his plantation, which allows of a detailed attention that could not be given to a larger one, but he thinks that there are very few plantations in that State which obtain a better return. With respect to Mr. Finck, we quote from his report rendered to the Department of Fomento:

"The product of each coffee tree varies greatly. Everything depends on the age of the tree, the soil and the cultivation that may be given to it, with or without manure; but as a general rule and as a first-class crop on plantations with an age of four to nine years, we obtain half a pound per tree; on a second class plantation with trees from nine to fifteen years of age, we obtain two ounces of coffee per tree.

"The annual returns from this and other counties of the State, vary every four years in obdedience to a law of rotation that fulfills the immutable laws of nature. During these four years, one good crop is obtained, another inferior and two medium crops, which can be represented by the following proportions: the good crop is represented by figure 4; the inferior by figure 2, and the medium by figure 3."

This law is general and is observed in almost all districts, although not in equal proportions; but making use of the numbers observed, it will be found in the State of Veracruz that the crops run in the following proportions: 8 ounces for a medium crop; 10.64 ounces for a good crop and 5.32 for an inferior.

Assuming the same law of rotation in Oaxaca, where the returns are slightly better, we obtain:

For a medium crop.....	16.00 ozs.
For a good crop.....	21.04 „
For an inferior crop.....	10.64 „

It ought also to be mentioned that during a longer or shorter period, but always included in two or more cycles of rotation, exceptional crops are found which are the maximum and minimum of the cycle to which they belong, and which crops sometimes reach the quadruple of the ordinary return, in which case they form the maximum; and sometimes go as low as the fourth part of the ordinary minimum of any cycle of four years, so that following the figures given by Mr. Finck, we can assume for the State of Veracruz a maximum crop of two pounds and a minimum of two ounces. At the same time, it is evident that the quadruple of the ordinary crop is not always the maximum of the cycle. In the State of Oaxaca, under the same calculation, we would obtain a maximum of four pounds, a return which has already been observed.

These variations give rise to more or less fabulous reports, but it is very certain that if observations were taken of the returns from all the plantations during the same year of any cy-

cle, few of them would show an ordinary return of more than one pound. It will be understood that the above rules do not apply to plantations which exist under exceptional circumstances, either through their climate and soil, or through the care given to their cultivation, especially by the employment of well selected manures, or by attention to both.

Our remarks with respect to returns, are not of much utility to those people who have their plantations already established; but we hope they will be of some use to those who propose to enter into the cultivation of coffee, as they might find themselves carried away by imprudent talk and by exaggerated statements from ignorant charlatans. Although it is very possible, it would nevertheless be a very venturesome thing for a man to undertake to obtain crops of over eight ounces under ordinary conditions. Besides this, a moderate crop will give higher profits, as can be seen by revising the accounts of expenses and profits which will be found at the and of this book, and these results can be obtained without any considerable risk.

ENEMIES OF THE COFFEE TREE.

The coffee tree has its enemies in both the vegetable and animal kingdom. The vegetable enemies, which undoubtedly are the most injurious, are represented by the fungi, lichens and orchids, which attack the tree and become parasites on its trunk and branches. When the coffee tree has advanced in years, and has not been carefully watched, the lichens invade the trunk and completely cover it. The orchids which are so abundant in tropical countries, are often found growing in the forks of the branches, where they suck the juices of the tree.

The development of these vegetable parasites can be prevented by keeping the trees always clean, both in their trunks and in their branches. When once the lichens have commenced invading the tree, and the orchids have taken root in the forks

of the branches, it is necessary to destroy them. This operation is perfectly simple and two laborers are enough to clean several hectares. The orchids are destroyed by hand, or when they have taken good root, by the help of a small knife. The lichens which cover the bark, can be destroyed by rubbing the trunk with a rough cloth or with a thin sheet of hard wood, but the cloth is preferable because it injures the bark less.

Amongst the animal enemies of the coffee tree, the first is the ant, which prefers to attack the roots of the tree. Its presence is recognized by the little heaps which it forms in the paths between the trees, and which we have sometimes seen reaching a height of fifty and sixty centimetres. The ant can be easily destroyed by means of ordinary commercial sulphuret of carbon, which is poured into the entrance of the nest through a small funnel, and when a sufficient quantity has been poured in, the entrance is closed with a damp cloth and the same operation is carried out in all the adjoining nests. These ant nests always have several entrances which must be attended to. When all the galeries are filled with sulphuret of carbon, it is set fire to at one of the entrances. The explosion which is produced by the ignition of the sulphuret, frequently raises the cover of the nest, which is thus destroyed.

Other enemies to the coffee tree are found in the larvæ of different species of the genus *Philofaga*, which attack the roots of the trees. Great injury is done to the plantation by these parasites, which often kill the recently transplanted trees, and when this is the case, the ground ought to be carefully examined before a fresh tree is planted. No certain means has as yet been discovered for the destruction of these larvæ, once the plantation has been formed, but to avoid their development, we can only recommend a careful preparation of the soil.

Two important plagues have recently appeared in some districts of Michoacán which threaten to kill off the coffee plantations and especially those of Uruapan, these are: the coffee louse and *carbón.*

In company with Mr. J. C. Segura, the Engineer, who was commissioned by the Departament of Fomento to study these plagues, I have had opportunities of observing the magnitude of the evil. It is my opinion, that the threatened evil is greater than is generally believed and that if no energetic steps are taken within the next few years, whilst the evil is only beginning, it will be useless later on. When my esteemed companion, Mr. Leopoldo Rincon y Blanco, visited the coffee plantations of Uruapan in 1889, the disease amongst the coffee trees had only commenced to develop, and no importance was attached to it. The matter has now become very much more serious.

When the coffee tree is attacked, it commences to show a languid appearance and its leaves become covered with a black powder which firmly adheres to the polished side of the leaf. This substance, which gives the trees a dark and somewhat repugnant aspect, is in this country commonly known under the name of *carbón* and is nothing more than the *fumagina*, a criptogam of the genus *demathium*, which is sometimes found on the orange tree. The appearance of the *fumagina* is a direct consequence of the attack of the louse, which exudes a substance that serves as a medium of nutrition to the *demathium*. The growth of the *fumagina* is not always confined to the leaves, but often invades the berry. Under excessive heat, this dark colored skin raises itselt from the leaf without breaking and falls off. Attempts have been made to utilize this fact with a view to destroying the pest, but no really good results can be obtained by this method. On the other hand, seeing that the *fumagina* disappears with the louse, the planter ought to direct his efforts to the extirpation of that insect.

The coffee louse [*dactylopius destructor*] has been carefully studied by our Professor, Mr. Segura, who after a careful observation of its character, has classified it in the genus *dactylopius* of the family of the *coccianus*. For want of the proper references, he could not determine its species on the spot, but

he has since confirmed his own opinion by that of Mr. C. V. Riley, the Entomologist of the Agricultural Department in the United States, who more particulary specifies it under the name of *destructor*.

This insect has given rise to many mistaken conjectures and opinions on the part of many persons in the district, for which reason Mr. Federico Atristain could not obtain any results in his investigations.

The destruction of the louse is not easy, nor does the remedy consist in a reckless pruning, as is shown by the ruins of some valuable plantation in Uruapan.

In those districts which were attacked, Mr. Segura left some valuable prescriptions with ample instructions for their use. These receipts are as follows:

1st.	Petroleum	20 quarts.
	Water	10 ,,
	Black soap	8 ozs.

The soap ought to be dissolved in boiling water, after which it is taken off the fire and the petroleum added.

2nd.	Petroleum	20 quarts.
	Sour milk whey	10 ,,

This mixture is boiled and the soap that is thus formed, is dissolved in 20 quarts of water. This mixture is recommended for calcareous formations.

3rd.	Potash	14 lbs.
	Soda, at 98°	8 ,,
	Unslaked lime	5 ,,
	Fish or seal oil	100 quarts.

The potash and soda are dissolved in 100 quarts of water. The lime is slaked in 20 quarts of the same liquid, to which the fish oil is afterwards added and the mixture stirred until it forms a homogeneous mass. The solution of potash and soda is then added in a boiling condition, and the whole stirred

for five minutes. It is then allowed to settle and when cold, 150 quarts of water are added.

4th.	Black soap	20 lbs.
	Sulphur	3 ,,
	Soda, at 98°	1 ,,
	Potash	1 ,,
	Water	1,000 quarts.
5th.	Soda	10 lbs.
	Potash	10 ,,
	Tallow	40 ,,
	Turpentine	40 quarts.

The soda and potash are dissolved in the necessary quantity of water and as soon as the tallow and turpentine are melted together, the potash and soda are mixed with all due precaution.

6th.	Unslaked lime	40 lbs.
	Sulphur	20 ,,
	Salt	15 ,,
	Water	600 ,,
7th.	Turpentine	20 lbs.
	Soda crystals	6 ,,
	Fish oil	4 quarts.
	Water	1,000 ,,

These formulæ are taken from the report which Mr. Segura presented to the Government of the State of Michoacán.

The liquids which are thus prepared, are sprinkled over the diseased trees, at first in the morning only; but should this not give the desired results, it can be done twice in each day. After the louse has disappeared, the treatment ought to be continued for several days. It will also be found convenient to diminish the number of branches, so as to allow the greatest circulation of air, and at the same time, to moderate the supply of water.

Statistics. Mexican statistics are as yet very backward in everything relating to agriculture, or it would be better said,

that no such statistics exist, because though a great deal of enthusiasm has been shown in collecting the necessary data, and prominent persons have devoted a good deal of time and trouble to this question at different times, their efforts have not succeeded in collecting anything like reliable information, and what little they have got, can not be relied on for any practical purposes. Any effort to collect information of this class always meets with great difficulty, but when these attemps are made with repect to agricultural products, the difficulties are greatly increased, as with very few exceptions, each planter forms in himself an unsuperable obstacle. The shameful deficiency of our national statistics is mainly due to the suspicious and jealous disposition with which these matters are treated by our agricultural population.

We cannot, therefore, set down any thing certain in this matter, without better information than that at present obtainable, and without a greater uniformity and precision in the form in which the returns are collected.

Up to the year 1889, it was found impossible to obtain a complete report of the weights and values of the agricultural products of the Republic, and these were presented in a work prepared by Mr. J. C. Segura and published by the Bureau of Statistics. From this report, we have extracted the tables relating to coffee, only giving the aproximate values which are set down by the author. This report contains the following paragraphs:

"In order to prepare these tables, a proper return paper was made and distributed in the month of February, 1890, and perhaps the difficulties which have been found in filling up the blanks are due to that delay, because the local authorities who were commissioned to procure the information, not knowing that they were about to receive any such commission, did not see any necessity of taking with the necessary anticipation, the proper steps to obtain the figures required during the agricultural year, for which reason the reports are estimated and put

down according to the local knowledge of the person filling them up. It will easily be understood from the above, that these tables are only an attempt to give statistics, giving the minimum of production, but if we take into acount the prejudiced resistence which the agriculturist shows to any inquiry into his crops, we must conclude that we have only got about a third or a half of the real figures."

Production of coffee during the year 1889.

States.	Districts, Counties, &c.	Kilograms.	Value.
Chiapas	Chiapa de Corzo	184,098 000	$ 48,000
	Comitán	4,602 500	1,500
	Chilón	966 525	210
	La Libertad	2,301 230	750
	Pichucalco	18,409 800	4,800
	Simojovel	36,819 700	8,000
	Soconusco	439,538 750	238,750
	Tuxtla Gutiérrez	11,045 980	2,400
Colima	Alvarez	85,422 078	46,400
	Colima	138,074 000	60,000
	Medellín	4,602 500	1,800
Guerrero	Alarcón	828 447	324
	Aldama	690 373	360
	Allende	2,715 452	1,062
	Bravos	552 300	360
	Galeana	3,221 720	2,100
	Morelos	46 025	30
Hidalgo	Huejutla	22,368 000	7,290
	Jacala	23,012 300	5,000
	Molongo	1,840 980	640
	Tulancingo	15,510 312	4,044
	Zacualtipán	552 300	120
Jalisco	Autlán	4,786 598	2,646
	La Barca	920 500	480
	Ciudad Guzmán	6,903 730	3,600
	Guadalajara	996 648	416
	Mascota	6,213 363	2,430
	Carried forward	1.017,040 111	$ 443,512

States.	Districts, Counties, &c.	Kilograms.	Value.
	Brought forward.....	1.017,040 111	$ 443,512
Jalisco.....	Sayula.....	7,410 005	2,518
	Tequila.....	14,727 900	7,040
México.....	Sultepec.....	368 197	192
	Temascaltepec.....	2,531 853	1,320
	Tenancingo.....	57,331 230	23,750
	Valle de Bravo.....	6,443.380	3,360
Michoacán.....	Apatzingán.....	506 272	198
	Ario de Rosales.....	.2,301 230	750
	Coalcomán.....	4,602 500	2,000
	Jiquilpan.....	9,205 000	3,000
	Tacámbaro.....	23,012 300	11,000
	Uruapan del Progreso.....	240,386 574	129,575
	Zamora.....	2,301 230	1,000
	Zitácuaro.....	3,497 868	1,520
Morelos.....	Cuautla Morelos.....	9,573 197	4,160
	Cuernavaca.....	124,267 200	59,400
	Jonacatepec.....	19,882 590	6,952
	Tetecala.....	2,485 328	1,180
	Yautepec.....	2,347 255	1,020
Oaxaca.....	Choapan.....	53,573 078	17,460
	Cuicatlán.....	4,602 500	200
	Ejutla.....	138 074	48
	Ixtlán de Juárez.....	115,062 500	30,000
	Jamiltepec.....	552 300	144
	Juchitlán de Zaragoza.....	9,205 000	2,600
	Juquila.....	36,819 700	9,600
	Juxtlahuaca.....	1,242 720	270
	Miahuatlán.....	36,819 700	14,400
	Pochutla.....	603,294 697	235,946
	Tehuantepec.....	3,681 970	480
	Teotitlán del Camino.....	5,243 846	1,144
	Tlaxiaco.....	23,012 300	10,000
	Tuxtepec.....	2,301 240	9,600
	Villa Alta.....	101,705 000	39,600
	Yautepec San Carlos.....	4,602 500	800
Puebla.....	Chiautla.....	1,610 863	105
	Huauchinango.....	138,074 000	36,000
	Matamoros.....	736 398	172
	Tepeji.....	4,602 500	1,600
	Carried forward.....	2.697,102 106	$1.113,616

States.	Districts, Counties, &c.	Kilograms.	Value.
	Brought forward.....	2.697,102 106	$1.118,616
Puebla.....	Tehuacán.....	92,050 000	40,000
	Tetela de Ocampo.....	69,037 300	30,000
	Teziutlán.....	187,779 970	57,120
	Tlatlauqui.....	32,317 200	14,000
	Zacapoaxtla.....	75,941 030	24,750
	Zacatlán.....	26,418 218	9,184
Querétaro	Jalpan.....	2,945 578	975
San Luis Potosí. ...	Ciudad de Valles.....	4,602 500	2,500
	Hidalgo.....	13,807 400	5,400
	Tamazunchale.....	46,025 000	16,000
	Tencanhuitz.....	266,942 700	80,400
Tabasco.....	Balancán.....	3,681 970	2,000
	Cárdenas.....	1,150 623	500
	Comalcalco.....	44,206 900	11,400
	Cunduacán.....	4,602 500	1,200
	Frontera.....	288 655	100
	Huimanguillo.....	9,205 000	3,200
	Jalapa.....	5,602 500	1,200
	Jalpa de Méndez...	13,807 400	3,600
	Macuspana.....	1,380 840	600
	Nacajuca.....	2,761 860	960
	San Juan Bautista.....	920 500	360
	Tacotalpa.....	6,903 780	1,800
	Teapa.....	18,409 800	7,200
Territory of Tepic..	Ahuacatlán.....	414 222	216
	Compostela....	552 300	192
	San Blas.....	1,104 598	480
	Tepic.....	40,961 920	21,360
Veracruz.....	Acayucan.....	8,974 845	1,950
	Coatepec.....	1.407,526 320	611,640
	Córdoba.....	957,089 543	415,900
	Cosamaloapan.....	34,116 898	8,384
	Chicontepec.....	9,849 324	4,708
	Huatusco.....	1.380,740 000	660,000
	Jalacingo.....	275,825 494	35,958
	Jalapa.....	148,015 398	51,450
	Minatitlán...	1,933 030	840
	Misantla.....	23,058 325	8,016
	Orizaba.....	319,779 377	138,960
	Carried forward.....	8.327,832 874	$3.388,119

States.	Districts, Counties, &c.	Kilograms.	Value.
	Brought forward.....	8.327,832 874	$3.388,119
Veracruz.....	Ozuluama.....	138 074	48
	Papantla.....	2,577 378	672
	Tuxpan.....	1,472 790	768
	Tuxtlas..... ..	18,409 800	8,000
	Zongolica.....	72,926 148	38,562
	TOTALS.....	8.423,357 064	$3.436,039

SUMMARY.

States.	Kilograms.	Value.
Chiapas	696,782 485	$ 304,410
Colima.....	228,098 578	108,200
Guerrero.....	8,054 317	4,236
Hidalgo.....	63,283 892	17,094
Jalisco.....	41,958 744	19,130
México.....	66,674 660	28,622
Michoacán.....	285,812 974	149,043
Morelos.....	158,555 570	72,712
Oaxaca.....	1.001,857 125	372,292
Puebla.....	628,567 479	212,931
Querétaro.....	2,945 578	975
San Luis Potosí.....	331,377 600	104,300
Tabasco.....	111,922 278	34,120
Veracruz.....	4.662,432 744	1.985,726
Tepic.....	43,033 040	22,284
TOTALS.....	8.332,299 064	$3.436,039

EXPORTS OF MEXICAN COFFEE TO FRANCE AND THE UNITED STATES.

Years.	France.	United States.	Total.
1885.....	$ 143,469	$ 979,538	$ 1.122,006
1886.....	123,094	1.380,756	1.503,850
1887.....	329,626	1.836,450	2.167,076
1888.....	171,083	2.112,130	2.283,213
1889.....	172,855	2.895,862	3.068,717
1890.....	.....	3.542,851	3.542,851

(Report of the N. Y Chamber of Commerce).

For purposes of comparison, we present the following table which sows the total production of the world during the year 1886–87.

	Pounds.
Brasil, Río Janeiro	391.664,000
„ Santos	289.072,000
Java	128.016,000
México & Central America	102.704,000
Venezuela	86.240,000
Hayti	44.800,000
West India Islands	34.160,000
India & Manilla	33.682,208
Island of Ceylon	17.409,952
Celebes Islands	14.347,200
Africa & Mocha	12.880,000
Padang, Sumatra	5.376,000
TOTAL PRODUCTION	1,160.351,360

(Report of the N. Y. Chamber of Commerce).

TABLE SHOWING THE EXPORTS OF MEXICAN COFFEE FROM 1878 TO 1892.

FROM THE REPORTS OF THE BUREAU OF STATISTICS.

Years.	Kilograms.	Value.
1878 to 1879	5,425.755,806	2.280,097 28
1179 ,, 1880	5,315.860,128	1.984,472 60
1880 ,, 1881	5,489.127,568	2.248,782 11
1881 ,, 1882	5,852.840,112	2.414,538 20
1882 ,, 1883	4,162.468,560	1.717,190 75
1883 ,, 1884	3,827.544,480	1.579,020 83
1884 ,, 1885	2,912.855,852	1.201,673 38
1885 ,, 1886	4,120.128,552	1.609,723 82
1886 ,, 1887	6,369.004,248	2.627,477 11
1887 ,, 1888	5,892.802.176	2.431,024 96
1888 ,, 1889	9,419.746,916	3.886,084 53
1889 ,, 1890	11,661.864,000	4.811,000 48
1890 ,, 1891	14,808.467,792	6.150,358 72
1891 ,, 1892	13,366.796,520	5.514,355 15

Expediture and returns of a coffee plantation with 100,000 trees, during seven years of operation.

1st. YEAR.	DEBIT.
Value of 65 hectares of land for the plantation @ $ 30	$ 1.950 00
„ „ 10 „ for buildings and offices	300 00
Two ordinary ploughings @ $ 1.50 per hectare	195 00
Digging 100,000 holes @ 37½ cs. per 50	750 00
Planting 25,000 banana trees @ $ 2 per 100, including purchase	500 00
Value of 200,000 seedling coffee trees @ $ 7 per 1,000	1,400 00
Setting out 100,000 @ 37½ cs. per 200	187 50
Replanting 20,000 lost trees (maximum)	37 50
Two weedings at the rate of ten avenues of 35 metres each for 37½ cents	769 60
Three waterings at $ 65 each	196 00
Expenses of management, taxes, etc	580 00
Interest on capital at 4 per cent	274 50
	$ 7,139 18

2nd. YEAR:	DEBIT.
Debit balance brought over from 1st. year	$ 7,139 18
Six weedings at $ 192.40 each	1,154 40
Seven waterings during dry season @ $ 65 each	455 00
Re-sinking of 5,200 holes for replanting @ 50 for 37½ cents	39 00
Replanting 5,200 trees to replace losses @ 200 for 37½ cents	9 75
Cutting 4,200 bunches of bananas @ 160 for 37½ cents	9 86
Expenses of management, taxes, etc	600 00
Purchase and setting up of machinery, payable in six years, (1st. year)	500 00
Interest on capital at 4 per cent	396 28
	$ 10,303 47

2nd. YEAR:	CREDIT.
Value of 270,000 bananas @ 20 cents. per 100	$ 540 00
Debit balance at end of year	6,763 47
	$ 10,303 47

3rd. YEAR:	DEBIT.
Debit balance brought over from 2nd. year	$ 9,763 47
Six weedings @ 192.40 each	1,154 40
Seven waterings during dry season @ $ 65 each	455 00
Re-sinking of 4,160 holes @ 50 for 37½ cents	31 20
Replanting 4,160 trees to replace losses @ 200 for 37½ cents	7 80
Cutting 8,500 bunches of bananas @ 160 for 37½ cents	19 87
Picking 70,000 lbs. of berries, producing 25,000 lbs. of clean coffee (first small crop of 4 ounces per tree) @ 30 lbs. for 25 cents	583 25
Expenses of management, taxes, etc	600 00
Purchase and setting up of machinery, payable in six years (2nd. year)	500 00
Interest on capital at 4 per cent	527 03
	$ 13,667 02

3rd. YEAR:	CREDIT.
Value of 510,000 bananas @ 20 cents. per 100	$ 1,020 00
Value of first crop of 250 quintals at $ 20 (on the plantation)	5,000 00
Debit balance	7,647 02
	$ 13,667 02

4th. YEAR:	DEBIT.
Balance brought foward from 3rd. year	$ 7,647 02
Six weedings @ $ 192.40	1,154 40
Seven waterings during dry season	455 00
Re-sinking of 1,040 holes @ 50 for 37½ cents	7 80
Replanting 1,040 trees to replace losses @ 200 for 37½ cents	1 95
Cutting of 11,300 bunches of bananas @ 160 for 37½ cents	26 25
Picking 140,000 lbs. of berries, producing 500 quintals of clean coffee (average crop of 8 ounces), at the rate of 30 lbs. for 18 cents	839 98
Preparation of 500 quintals of coffee @ 10 cents (maximum)	50 00
Expenses of management, taxes, etc	600 00
Purchase and setting up of machinery, spread over 6 years (3rd. year	500 00
Interest on capital at 4 per cent	452 33
	$ 11,634 00

4th. YEAR:	CREDIT.
Value of 678,000 bananas @ 20 cents. per 100	$ 1,356 00
Value of 500 quintals of coffee @ $ 20 on the ground	10,000 00
Debit balance at the end of 4th. year	378 73
	$ 11,734 73

5th. YEAR:	DEBIT.
Balance brought over from 4th. year	$ 378 73
Six weedings @ $ 192.40 each	1,154 40
Seven waterings during the dry season @ $ 65	455 00
Re-sinking of 346 holes @ 50 for 37½ cents	2 35
Replanting 346 coffee trees @ 200 for 37½ cents	75
Cutting 14,000 bunches of bananas @ 160 for 37½ cents	32 82
Picking 170,000 lb. of berries, producing 75,000 lb. of clean coffee (a good crop of 12 ounces per tree), at the rate of 80 lbs. for 18 cents	1,019 88
Treatment of 750 quintals of coffee @ 10 cents	75 00
Expenses of management, taxes, etc	600 00
Purchase and setting up of machinery spread over 6 years (4th. year)	500 00
Intereset on capital at 4 per cent	170 19
Credit balance at end of 5th. year	12,290 88
	$ 16,680 00

5th.	CREDIT.
Value of 840,000 bananas at the rate of 20 cents per 100	$ 1,680 00
Value of 750 quintals of coffee @ $ 20 on the plantation	15,000 00
	$ 16,680 00

6th. YEAR:	DEBIT.
Six weedings @ $ 192.40	$ 1,154 40
Seven waterings during the dry season @ $65	455 00
Re-sinking 200 holes @ 50 for 37½ cents	1 80
Replanting 200 trees to replace losses	37
Cutting 15,000 bunches of bananas @ 160 for 37½ cents	85 15
Picking 280,000 lb. of berries, producing 100,000 lbs. of clean coffee (splendid crop) @ 80 lbs. for 18 cents	1,679 94
Carried forward	$ 3,326 66

		DEBIT.
Brought forward	$	8,826 66
Treatment of 1,000 quintals of coffee at 10 cents		100 00
Manure for 65 hectares @ 2.75 each		178 75
Expenses of management, taxes, etc		500 00
Interest on capital at 4 per cent		188 20
Credit balance at end of 6th. year		29,797 27
	$	34,090 88

6th. YEAR:		CREDIT.
Credit balance brought over from 5th. year	$	12,290 88
Value of 900,000 bananas @ 20 cents. per 100		1,800 00
Value of 1,000 quintals of coffee @ $ 20		20,000 00
	$	34,090 88

7th. YEAR:		DEBIT.
Six weedings @ $ 192.40	$	1,154 40
Seven waterings during dry season @ $ 65		455 00
Re-sinking 100 holes @ 50 for 37½ cents		75
Replanting 100 trees		37
Cutting 15,000 bunches of bananas @ 150 for 37½ cents		35 15
Picking 270,000 lbs. of berries, producing 75,000 lbs. of clean coffee (good crop of 12 ounces per tree) at the rate of 30 lb. for 18½ cents		1,019 88
Treatment of 750 quintals of coffee at 10 cents		75 00
Expenses of management, taxes, etc		600 00
Purchase and setting up of machinery, spread over 6 years (6th. year)		500 00
Interest on capital at 4 per cent		143 62
Credit balance at end of 7th. year		41,893 40
	$	45,877 57

7th. YEAR:		CREDIT.
Balance brought over from 6th. year	$	29,197 57
Value of 840,000 bananas @ 20 cents. per 100		1,680 00
Value of 750 quintals of csffee @ $ 20		15,000 00
	$	45,877 57

MEXICO, CUERNAVACA AND PACIFIC RAILWAY.

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CITY OF MEXICO.

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President and General Manager.

J. M. BRASH,
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This is the great scenic road of México. From the moment the train leaves the initial station until it reaches the summit, 2552 feet above the City of Mexico, and 9,898 feet above sea level, an agreeable and continuous excitement prevails amongst the tourists, produced by the many varied and novel scenes and beautiful panoramas presented to the view in rapid succession. The line touches the suburban towns of Santa Julia, Tacubaya, and Mixcoac, and passes through well cultivated fields and orchards until it reaches the villages of Magdalena and Contreras, at the base of the great Ajusco range of mountains. Thence the road gradually climbs upward, around mountain sides until it penetrates into the corn and wheat covered hills around Ajusco, from which it emerges into the great forest of the Monte de Huitzilac in the State of Morelos. From the point known as the Great Cut, kilometer 41, is seen the most remarhable and extensive panorama, glimpses of which are presented on the whole length of the line.

This panorama embraces the entire Valley of Mexico, the Anahuac of the ancients, with its silvery lakes, Texcoco, Chalco, and Xochimilco, the City of Mexico, the legendary Tenochtitlan, with the gray towers of the Cathedral, the majestic Castle of Chapultepec, broad fields and picturesque towns, villages, hamlets, and farms which, from that elevation, appear to be promiscuously scattered over the vast expanse below; and in the far distance are the famous volcanos, Popocatepetl and Ixtacyhuatl.

The great forest of the Monte de Huitzilac, thorough wich the road passes, is one of the most notable in the Republic. The gigantic and umbrageous trees raise their foliage over 300 feet into the balmy air, while the green grass which carpets the gently undulating ground gives an enchanting prospect to the view. The point known us Fierro del Toro, where the Railway crosses the old stage road from Mexico to Cuernavaca, and the Cruz del Marquez which dates from the time of Cortes, are both historic, and are the theme of many thrilling stories and romantic legends.

The location of the line for the descent to the beautiful City of Cuernavaca, 4,920 feet below, is through a picturesque and cultivated country; and the panoramas of the rich and productive Valley of Cuernavaca, stretching away down for some 75 miles, covered with great sugar plantations and orchards of every kind of luscious tropical fruits, are as romantic and enchanting as those of the Valley of Mexico. An excursion over the Mexico, Cuernavaca, and Pacific Railway is sufficient to prove that it is the unrivalled scenic road of Mexico, and perhaps of any country.

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